NORWOOD's SYSTEM OF Navigation:

Teaching the WHOLE ART,

In a way more Familiar, Easie, and Practical,
Than hath been hitherto done.

SHEWING,

The Projection of the *Plain Scale*: the Sphere in *Plano*: *Astronomical Problems* useful in Navigation: *Traverse Tables*: Right lin'd *Triangles*, Geometrically, by Tables of *Sines*, *Tangents*, *Logarithms*, and by *Gunter's Ruler*; applied to *Plain* and *Mercator's* Sailing. Illustrated by *Schemes* on Copper-Plates. How to make *Observations* at Sea or Shore. Sure and easie ways of *Reckoning* by *Latitude*, *Longitude*, and *Meridional distance*; With Tables for both ways of *Sailing*. The *Longitude* and *Latitude* of principal Places. Tables for the *Suns Place* and *Declination*; Of the *Longitudes*, *Latitudes*, *Declinations*, *Right Ascensions*, and *Seasons* of some noted *Stars*. *Spherical Triangles*; and their Use in *Great Circle Sailing*. The Use of the *Globes*, *Azimuth Compass* for Variation. And also of *SEA-GUNNERY*.

The Description and Use of a New Instrument, called *Encyclologium*, or the Sliding Circles; which, with ease, resolves all Questions of Proportion, Trigonometry, Arithmetick, Square and Cube Root, Gunnery, Mensuration, and *Dyalling*.

By *MATTHEW NORWOOD*,
Teacher of *Mathematical* ARTS.

LONDON: Printed for *H. Sawbridge*, at the Bible on *Ludgate-hill*; and *T. Wall*, next the *Tolzey* in *Bristol*. 1685.

To the Right Honourable

GEORGE, Lord Baron of *Dartmouth*, *Maſter General of His Majeſties Ordnance and Armies, Maſter of the Horſe to His Majeſty, Lieutenant of his Majeſties Foreſts of* Holt *and* Wilmore, *and one of His Majeſties moſt Honourable Privy-Council.*

MY LORD,

THE enſuing Papers humbly beg they may adventure upon the Publick under your Illuſtrious Name. They are deſigned for one of the Nobleſt Uſes that can concern this Iſland, and (not rudely to approach your Lordſhip with an Obvious or Unſtudied Offering) they are the Reſult of a long Theory and Experience, deriv'd to me by Traduction, an early Education, and other Impreſſions very powerful and indelible. I have hopes to be accepted

in this Addreſs, from your Lordſhips propitious Inclinations towards all who any way promote the Engliſh Intereſt, and Title to their Navigable Country the *Ocean*. A Title and Intereſt, my Lord, which your Honourable Self has proſecuted and made good, under the *Greateſt and Braveſt Admiral*, with ſingular Renown. And your Goodneſs being equally match'd with your Valour and Conduct, and both eminently conſpicuous; I crave the benefit of its Influence and Favour, and above all, the great Honour of being,

MY LORD,

Your moſt Obedient,
moſt Humble Servant,

M. NORWOOD.

To the Right Honourable

The Master, Wardens, and Assistants

OF THE

Trinity-house of *Deptford-Strand.*

BOoks on a subject of so great benefit to the Publick as this I Treat of, may expect a favourable Reception from the World; upon that very consideration, I entertain not my Reader with nice and useless Speculations, but have endeavour'd to promote and advance a Science wherein the Safety, the Wealth and Glory of the English Nation is so much concern'd. The Art I undertake to Teach, I am intituled unto (as it were) *Hæreditario Jure*, as being derived to me from my Father, who early instructed me herein, and whose Abilities to perform it, are too well known to be doubted of; and which by many years experience in Navigation, I have labour'd to make perfect. I do not onely lay down *Theorems* for the institution of young Sea-men, but have endeavour'd at once, both to instruct and demonstrate; and thereby made Navigation more easie to be learned, because so easie to be understood.

That I have inscribed your Names to it, is for that you being the ablest Masters in this Art, are the

the moſt capable Judges; and if my Performance herein may have your Approbation, and your Allowance, give it an *Imprimatur*; I ſhall be the leſs concern'd for the malignant Cenſures of the Envious or the Ignorant, who either begrudge others of the juſt Commendation due to their Induſtry, or elſe condemn what they do not underſtand.

I have in this Treatiſe added ſome things new, (beſides the Method I have explained in this part of the Mathematicks) the uſefulneſs whereof, and what further Improvements may be made therein, you will perceive in the peruſal. I am now grown grey in the many Experiences I have had in this Art, and not ſo capable for the toils and labours of Travel, and Navigation.

May I, by your favourable Influence and Recommendation, be directed into ſome ſafe and quiet Harbour, wherein I may ſpend the reſidue of my days in promoting this uſeful Art, to which I have devoted a great part of the Studies of my former life; it is all that I have to deſire in this World: and this I the rather do, that I may be in a capacity to ſerve my Country, and lay hold on all occaſions to demonſtrate how much I am,

SIRS,

Your moſt humble and obedient Servant,
and Younger Brother,

Mat. Norwood.

The Preface.

SInce Cuſtom ſo much prevails with moſt men, it may be expected I ſhould ſay ſomething of this Treatiſe, and of my ſelf, why I undertook it. To the firſt, I think fit to give my Reader this account: That beſides the defect of ſufficient demonſtrations in the ſeveral Books already extant on this ſubject, I found many Materials, *neceſſary to a practical Navigator, wanting; therefore to ſupply thoſe defects, and make the whole Art more intelligible, I adventured this* Syſtem *abroad. If at its firſt appearing in the World it receive not that eſteem which ſome other Writers pretend to; yet I am perſwaded, by experience 'twill be found much more uſeful, and that its evidence will give its own commendation. I have here incerted nothing but from my own Practice and long Experience, and whereon you may with ſafety depend; and in all difficulty, I have given the moſt natural Reaſon for demonſtration of every Rule; which is the chief and onely thing that hath been ſo much wanting in our late Books of Navigation. My long Practice, and Converſation with Marriners, hath diſpoſed me to a Stile and Language more familiar and beſt known to them, which may render me the more capable to inſtruct them.*

The reaſon which engaged me in this Work was, for that I obſerved ſome Books of this nature had paſſed divers Impreſſions, which for the greateſt part were collected from other mens Works, but more eſpecially from my Father's, Mr. Richard Norwood, *whoſe Skill in Mathematical Learning is ſo well known, that it needs not my commendation; yet I think my ſelf by Nature obliged to reſcue his Reputation from the diſingenious attempts of thoſe that printed his* Triangles *and* Sea-mans Practice, *ſo defective and different from the Original; where ſome whole Sheets are omitted, and others altered, under pretence of rendring them better; which thoſe who well underſtand it, do judge their Books to be ten times worſe. There's no doubt, but Covetouſneſs and Ignorance*

norance too much prevailed on the Persons concerned in those Copies; which in the end I believe will prove their disadvantage. It's sometimes the fate of ingenious men, to have their Reputations sullied, after they are dead, by ignorant or inconsiderate men, who vainly endeavour to advance themselves upon their silent Graves. How strange and unbecoming was it, in a man of Art and Learning, and he but a Corrector too of Mr. Sturmies Book, to mingle so much Dirt with his Ashes! What Considerations could more strongly incite a generous and learned man, either to have covered the Indecencies of that Author, or obliged the World with a more accurate and compleat Body of Navigation of his own? I am very prone to believe, those who manage themselves no better on shore, never had much experience of their own Books, Drafts, and Kalendars at Sea. And there are some, who blush not to tell us in print, of the general Approbation their Books have obtained, from men whose Knowledge and Experience is not inferiour to any Navigators in the WHOLE WORLD: a Flourish that exceeds all Comparison, and too great for my belief, without better evidence than that Author's bare word. It may be much doubted, how an able Mathematition, not bread a Marriner, should be so great a Judge of the practical part of Navigation: Methinks the Ingenuity of honest Mr. Philips (a Person not inferiour to our late Authors) is much more eligible; who in the close of a late Epistle in his Advancement to Navigation, doth modestly confess, That many of his Conclusions are proposed for Tryal and Approbation: which Work, though it be new, yet it's his own; and may perhaps prove more useful, than some others under a greater Countenance and Character.

All I shall further adde is, that I have made the Principles of this Art more plain than any System of Navigation I have yet seen; by a more elaborate and evident demonstration, and with such variety of Examples, as may best illustrate the truth of every Proposition, to the understanding of the Learner; wherein you will find the more abstrusive and difficult matters of this Art, are accommodated to the meaneſt Capacity: as, the explanations of the general Axioms of Spherical Triangles, Gunter's Ruler (or Lines)

applied

applied to Plain and Mercator's *Sailing*, &c. *And to render this Piece more compleat, I have added ſo much of Square and Cube Root, and Gunnery, as is neceſſary for an ordinary Navigator, or Sea-Gunner.*

I have alſo annexed a new Inſtrument called Encyclologium, *or* the Sliding Circles, *which with the greateſt eaſe imaginable, reſolves all Queſtions in Trigonometry, Square and Cube Root, Arithmetick, Gunnery, Menſuration, Gauging, Proportion,* &c.

It's near twenty years ſince I writ the Sea-mans Companion, *while I was young, and capable of ſerving my King and Country in no better ſtation; and had no thoughts of appearing again in print. In my tender years I was deſigned to the ſtudies of a more quiet Employment, but the knowledge I acquired (by my Father's inſtruction) in the Mathematicks; and the natural delight I took in Navigation, engaged me in that way of Livelihood; and before I was twenty years old, became Maſter of a very good Ship, wherein I continued until I was commanded to go Maſters Mate of the* Saphire, *where I ſpent ſome years in the Service againſt the* Turks; *that War being over, I had the Command of a Merchant-man for ſome time, until the beginning of the firſt Dutch War; when I accepted a Commiſſion from his preſent Majeſty, for a Lieutenants place in the* York *Frigot, under the Command of Capt.* Swanly; *and from thence I was removed to the Command of a Prize of forty four Guns. In the Command of this Man of War, I continued for ſome time; and afterwards ſerved his Majeſty in the* York: *but being much importun'd by ſome Gentlemen, Merchants of* London, *I was perſwaded by them to undertake difficult and hazardous Voyages: wherein, as it pleaſed God to bleſs me with great ſucceſs, to the more than ordinary advantage of my Employers, (having performed two Voyages, both in eight months, and therein returned with twenty four Whales, which ſold for* 5800l.) *ſo alſo in theſe Undertakings, I have had the Oportunities of making very uſeful Obſervations, to my great advantage, and experience in the practical part of Navigation.*

This was an Adventure to the West Ice *for Fish, wherein I saw no Land until my return. And in this dangerous Service, I was the first English-man, that ever made the Attempt.*

I thought it not amiss to give this account of my self: And therefore if any follow the Garb of the invidious Critick, to censure this Digression, and call it by an ugly hard name, (if that be all) I'll forgive them, knowing I am not without faults: for I doubt not, but herein will be found some small Omissions, that may not directly relate to this Subject: and for such I shall beg no Excuse; but for what's well or ill done herein, I willingly submit it to any fair and competent Judge, wishing a Blessing upon all our honest Undertakings, is the unfeigned desire of

Your faithful Friend,

M. N.

AN

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In any Parallel of Latitude, to know how many Leagues will anſwer to one Degree of Longitude in that Parallel; is after the Tables of Logarithms.

The

The Author's Habitation being above an hundred miles from London, *these Faults have escaped the Press; which are placed here in this method, that they may be (with more ease) corrected with your Pen.*

Pag.	Lin.	For.	Read.
5	10		P P (with the length of the given Line
10	14	E S	E L
10	16	B I	Æ I
18	24	which	with
20	27	6 L	L
20	29	B E	D E
21	9	E	K N
21	21	6 Z	62
21	23	S R	8 R
21	33	6 S	68
30	17	C	A
30	21	A D	B D
36	25	58	48
36	27	North leagues	South degrees
41	34	I wonder at it	I wonder not at it
94	27	100	108
94	28	32. 7	92. 7
94	28	West N W	Nor. Nor. West
97	2	*Virienia*	*Virginia*
99	4	colume	Line
101	29	C B	C D
101	31	bares some the Island	Goeth
104	10	Site-Vane	Shade-Vane
104	32	Scale	Staff
105	26	compt	Complement
110	13	Sun	Equinoctial
110	16	must be nearer to the Zenith, which is equal to the Latitude	by the declination, and the declination must be substracted
112	6	the Line	the Arch-line
125	11	26. 45	27. 45
146	2	fifth	Fish
154	27	1200	resolvand
162	13	O G	O L
167	9	A	A C
175	16	including	included
182	4	29	90 *deg.*
190	13	C B	C B 117
191	23	then	the side B C 117 leag.
194		in the Triangle	draw a line from A to B
195	16	to, *t.* D	to *tang.* D 30
195	23	D	C
196	13	B D	C D
197	2	559	359
201	2	72	372
208	16	99	90 *deg.*
210	17	63	244
213	16	A D B	A R B
213	20	these	Oblique
225	24	for it falls	for if it falls
231	1	minutes	minutes 00′
235	28	10th day	16th day
236	1	10th day	16th day
9	5	(4)9841871	*tang.* (9)8248926
9	6	10.1588128	(10) 1751073
237	16	7. 18	5 *deg.* 17′
237	19	1 *deg.* 00′	1 *deg.* 40′
238	2	23	29
238	5	28	38
239	23	00 : 53	26 : 53
239	31	92 : 29	89 : 19
240	8	124 : 43	134 : 43
247	1	begin	be given
269	16	*s.* B R	*s.* B
273	25	O ≏ *b*	O ≏ 6
274	9	R ≏ 6	R ≏ *b*
278	16	Angle	Triangle
282	21	659 : 00	61 : 59′
283	16	at Operations	at 3 Operations
302	5	leave out	*going*
310	16	which is in	within
319	15	(stated)	(later)
320	25	serve	so are
347	16	grea	Great
357	12	B	A B
358	*last*	First of *April*	Tenth of *April*
379	16	As the Root	As the Cube Root
379	18	So is the Root	So is the Cube Root
380	7	division oun.	division is ounces
380	25	Case	Question
384	10	Sulphur	Sulphur or

In page 310, the three last lines are thus to be read:
This A I 31 *deg.* 46′ being substracted from A G 99 *deg.* 10′ (the *Suns* distance from the *North Pole*) there remains 67 *deg.* 24′ for I G.

Hypothinuse, and some literal Mistakes, and Mis-pointings, must be excused.

Advertiſement.

THeſe and all other Mathematical Inſtruments for Sea or Land, with Maps, Globes, Sea-Plats, Carpenters Rules, Compaſſes of all ſorts, Poſt and Pocket Sun-Dyals for any Latitude; are moſt exactly made, and ſold by Mr. Walter Hayes *at the* Croſs-Daggers *in* Moor-fields, *next door to the Popes Head Tavern, in* London.

Mathematical and Sea-Inſtruments are alſo made by Mr. Anſelm Jenner *in* Briſtol.

OF GEOMETRY.

CHAP. I.

Geometrical Principles.

PROBL. I.

How to raiſe a Perpendicular from the middle of a Line given.

Fig. I. A *Perpendicular* is a Line drawn ſo directly from another Line, that it neither leans or inclines one way or other, but is upright; ſo that where it toucheth the other, it makes two Right Angles (as at O) namely, E O B equal to E O A. It is raiſed thus: Fix one foot of your Compaſſes at either end of the given Line as at A and B, and with the other, extended to above half the length of the ſame Line, deſcribe an Arch over the middle of it, as C C, then carry that diſtance to the other end of the given Line, and croſs that with another D D, interſecting in E; from the place of their interſection or cutting one another, draw the Line O E to the middle of the given Line, and it will be a true *Perpendicular*.

PROBL. II.

To divide a Line into two equal parts by a Perpendicular.

Fig. II. LEt the given Line be A B, and let it be required to divide it into two equal parts by a *Perpendicular*: Open the Compaſſes to any convenient diſtance, above half the length of the given Line,

as here from A to E, and D, and with that distance, fixing the Compasses at any end of the Line, as at A describe the Arches D and E above and below; then carry the same distance to the other end of the given Line B, and cross those Arches by the Arches C and F; and from the points of their intersection O and O, draw the Line O O, and it will cut the Line in the middle in S, and is a Perpendicular.

PROBL. III.

To raise a Perpendicular *from the end of a Line given.*

Fig. III. THe Line given is A B: Now it is required to raise a Perpendicular from the end of that Line (let it be from B.) Open your Compasses to any convenient distance, and fixing one foot in B, describe the Arch L C S. That done, from L set the the semi-diameter of that Arch to C, and from thence describe the Arch V V (above) then set your distance from C to S, and cross that Arch with the Arch R R; and from their intersection at O, draw the Line O B to the end of the given Line at B, and it is a Perpendicular.

PROBL. IV.

To perform the same another way.

Fig. IV. IT often falls out, that a *Perpendicular* is to be raised so near the edge of a Board or other thing, that there may not be room to raise it the way before-mentioned, and therefore 'tis requisite to know some other way. Let A B be the given Line, from the end of which I would raise a Perpendicular: Open your Compasses to any convenient distance, and from the end of the Line, as at B, describe the Arch C D; then from C set your Compasses (with that distance) to D, and describe the Arch E F G; and set the same distance from C three times upon that Arch, at E F G, and from G draw the Line G B, and it is a Perpendicular from the end of the given Line.

PROBL. V.

To let fall a Perpendicular *from a* Point *above, to a Line given.*

Fig. V. ADmit I would let fall a *Perpendicular* from the Point O, to the Line A B; from the assigned Point O, draw a Line at pleasure

pleaſure to the given Line, ſo as it may be acute or inclining, not near a Perpendicular, as the Line O A is; that Line divide into two equal parts, as at R, and upon R (as a Center) deſcribe the Arch O N, and where it cuts the given Line (which is at N,) let fall the Line O N, and it is a Perpendicular to the given Line, which was required.

PROBL. VI.

To draw a Line parallel *to a Line given.*

Fig. VI. LEt the Line given be A B, parallel to which I would draw another Line: (*Note*, A Line parallel to another Line, is a Line that runs ſo directly as another Line doth) that if they were both continued out infinitely, they would never meet, or come nearer, but continue at the ſame diſtance from one another:) therefore open your Compaſſes to the diſtance you are minded to ſet them aſunder, and go towards one end of the given Line, as at O, and deſcribe an Arch C C; carry the ſame towards the other end, as at O, and deſcribe an Arch, as D D; and by the tops of thoſe Arches draw a Line, and it will be parallel to the given Line.

PROBL. VII.

To draw a Line parallel *to a Line given, from any Point aſſigned, over the given Line.*

Fig. VII. THe Line given is A, the Point aſſigned is ⊙: Take the neareſt diſtance from ⊙ to the given Line, ſweeping it, and carry it towards the other end of the given Line, and deſcribe an Arch C C, then draw a Line by the top of that Arch, from the Point aſſigned, and it ſhall be a *parallel* Line to the given Line A, as was deſired.

PROBL. VIII.

To draw a Line parallel *to a Line given, from any Point aſſigned, not over the Line.*

Fig. VIII. LEt the Line given be A B, the Point aſſigned ⊙, and I would draw a Line from thence, parallel to the given Line A B. Take the diſtance from the end of the given Line at A, to the aſſigned Point ⊙, and carry it to the other end of the given Line, at B,

and describe an Arch C C; then take the length of the given Line A B, and set one foot of your Compasses in ⊙, and with the other cross that Arch C C, and by the point of their intersection at S, draw a Line from the given Point, as O S, and that Line shall be parallel to the given Line A B.

PROBL. IX.

To make an Angle *equal to an* Angle *given.*

Fig. IX. AN *Angle* is made by the intersection of two Lines crossing one another, and not being directly joyned, as the two Lines C A and B A do cross each other in the Point A; and so A is the angular Point, and the quantity of that Angle is the Arch of the Circle C B, described upon the angular Point A.----Now to make another Angle equal thereunto, as the Angle at D. First draw a right Line D E, it matters not of what length (for the length of the Lines do not increase the Angles quantity at all, but the Arch of the Circle comprehended between the Lines;) then on the angular Point given A (with your Compasses opened to any convenient distance) describe the Arch B C; your Compasses open to the same distance, set one foot of them in the Point D, and with the other describe the Arch E F; then with your Compasses take the distance between B and C, and set the same upon the other Arch from E to F, and draw the Line D F: So shall the Angle at D be equal to the Angle at A, which was required.

PROBL. X.

Three Right Lines *being given (of which the two shorter together must be longer than the longest) to make a* Triangle *whose* sides *shall be equal to those three given Right Lines.*

Fig. X. LEt the three Lines given be C, D, and E. First, take the Line C in your Compasses, and make the Line F G equal thereunto. Secondly, Take the Line D in your Compasses, and setting one foot in G, with the other describe the Arch H H. Thirdly, Take the Line E in your Compasses, and setting one foot in F, with the other describe the Arch S S, crossing the former Arch in K. Lastly, Draw the Lines G K and F K, and they shall constitute the Triangle G K F, whose sides are equal to the three given Lines, as was required.

PROBL. XI.

How to make a Geometrical Square, *whose four sides shall be equal to a given* Right Line.

A *Geometrical Square* is a Figure whose four sides are all equal, and whose Angles are all Right Angles.

Fig. XI. LEt the given Line be S; take the length thereof, and make the Line T V equal to it: then on the end T (by the third or fourth Problem before) erect the Perpendicular T X equal also to the given Line S; then set one foot of your Compasses in X, and with the other describe the Arch P P; also set one foot in V, and with the other describe the Arch R R, crossing the former Arch in K. Lastly, draw the Lines V K and X K, and you shall have constituted a *Geometrical Square* whose sides shall be equal to the given Line S, as was required.

PROBL. XII.

To find the Center *of a* Triangle, *or of any three Pricks given, provided they be not in a streight Line.*

Fig. XII. ANy three Points which lie not in a streight Line, they will be three Angles of a Triangle; so here, let the three Points given be A B C. For the doing this, divide any two of the sides of the Triangle into two equal parts, by two Perpendiculars, as you are taught in the second Problem before-going; and where them perpendicular Lines intersect one another, there is the Center of the Triangle, as here the Perpendicular Line dividing C B is D D, and that dividing the side A C is E E: Now these intersect each other in O, which is the Center required. The like is to be understood in finding the Center of a Circle: the three corners of the Triangle may be three pricks in the Circle, and then proceed as here you have done. But by this you may see, that a Line that goeth from one side of a Circle to the other (drawn at pleasure) if that Line be divided into two equal parts by a Perpendicular, the perpendicular Line will go through the Center, and therefore 'tis but continuing it out from one side of the Circle to the other, and the half of that Line which is so contained, is the semi-diameter of the Circle, as half L L is from O the Center.

PROBL.

PROBL. XIII.

Two Points *within a* Circle *being given, how to find the* Center *of the* Arch *of a* Great Circle, *which ſhall paſs through thoſe two given* Points.

Fig. XIII. A *Great Circle* upon the *Sphere*, is ſuch a *Circle* as divideth the *Sphere* into two equal parts; and ſo, the *Arch of a Great Circle* deſcribed upon a Plain, is ſuch an Arch as divideth the circumference of the primitive Circle given, into two equal parts.

To perform this. Let GBHD be the *Primitive Circle*, whoſe center is C, and let the two given Points within the ſame, be X and Y. Firſt, through one of the given Points (as X) and the center of the Circle C, draw the Line X C, extending it towards F: Upon this Line from the center C, erect the Perpendicular C B, and draw the Line B X, cutting the given Circle in G, through which Point G and the center, draw the Line G C H: Then, through the Points B and H draw a Line, extending it till it cut the Line X F in R; ſo you have found a third Point, namely R, through which the Arch of the Great Circle muſt paſs: And now, having three Points, X, Y and R, you may through them (by the laſt Problem) draw the Arch of a Circle, namely the Arch A X Y L R, whoſe center will be at K, and whoſe Arch will divide the Primitive Circle given, into two equal parts, in the Points A and L.

Theſe two laſt Problems are of ſingular uſe in Projecting of the Sphere in Plain by Circular Lines, and in meaſuring of the Sides and Angles of Spherical Triangles upon that Projection: Of which in this Treatiſe we ſhall hereafter treat in due place. As alſo in Great Circle Sailing, and Problems in Geography and Aſtronomy.

The End of the Geometrical Problems.

CHAP.

Fig. I

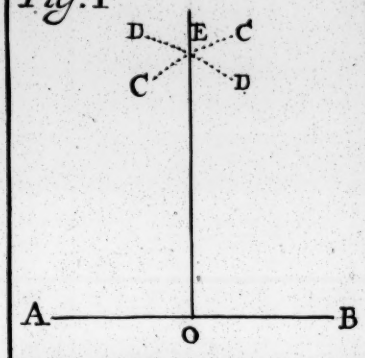


Fig. II

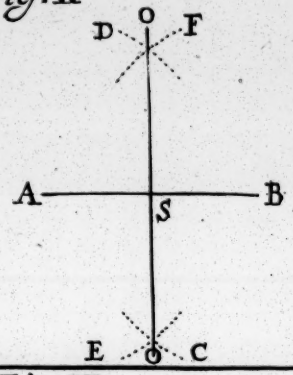


Fig. III

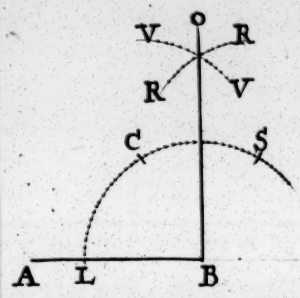


Fig. IV

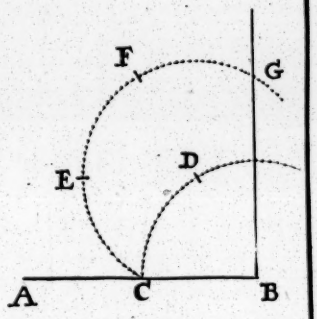


Fig. V

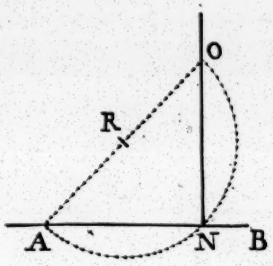


Fig. VI

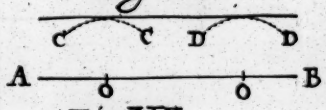


Fig. VII

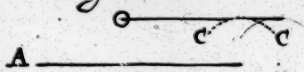


Fig. VIII

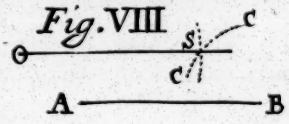


Fig. IX

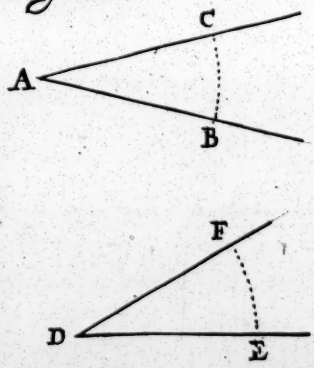


Fig. X

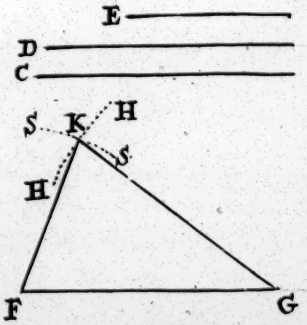


Fig. XI

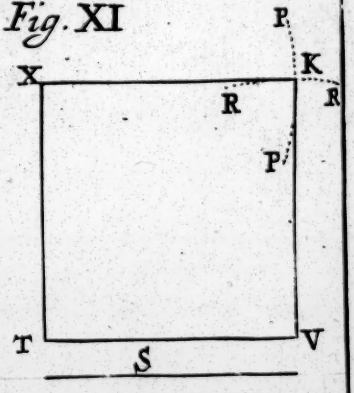


Fig. XII

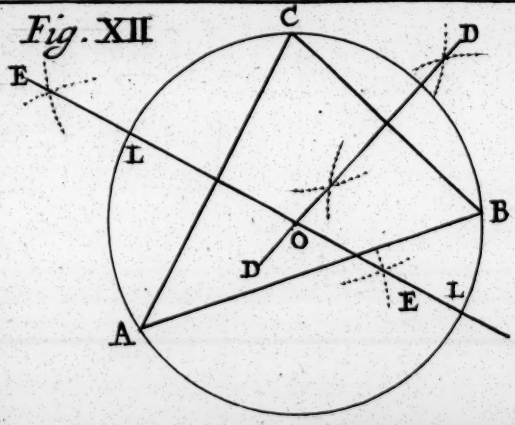
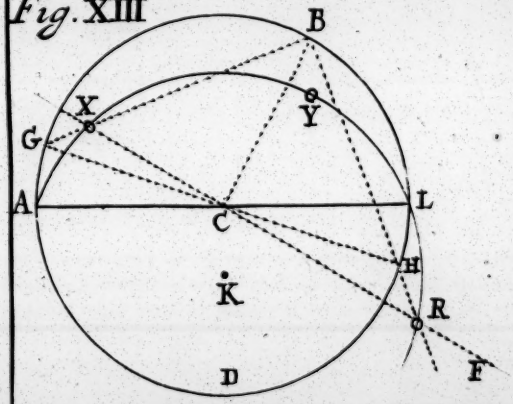


Fig. XIII



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CHAP. II.

Of the Projection of the Mariners Sea-Compaſs.

Fig. I. THe Compaſs conſiſts of thirty two Points, and ſo is nothing elſe but a Circle divided into thirty two equal parts. Now for the doing of it, upon one center deſcribe three Circles as you ſee in the Figure following; that done, draw a Line through the center, and it divides them all into two equal parts or Hemeſpheres; then divide that into two equal parts by a Perpendicular, (from the outer Circle) and ſo the Circles are all divided into four equal parts, by the Lines W E and S N, which Lines ſhall repreſent the Points of North, South, Eaſt, and Weſt: this done, divide theſe four, each into two parts, and draw (from the center) thoſe diviſions from the outer Circle to the inner Circle of all, then is the whole Circles divided into eight parts.

Then divide thoſe into two equal parts, and draw the Points from the outer Circle to the innermoſt (as you did the laſt) and make the Points, obſerving to make the North Point a whole point, and ſo ſucceſſively: The reſt of the Points will be (every other) a whole point; and your Compaſs now is in ſixteen Points.

Laſtly, divide theſe into two equal parts, and draw them from the outward Circle to the innermoſt of the greateſt Circles; and thus you have your Compaſs divided into thirty two Points: if you will divide the parts again, it makes the half points, and is drawn to the third Circle; that divided, makes the quarters, draw them to the ſecond Circle, and your Compaſs is finiſhed, as is ſignified in Fig. I. following.

CHAP. III.

The Projection of the Mariners Plain Scale.

Fig. II. THis Scale is made thus: Deſcribe a Semicircle upon the Line A B, and divide it into two equal parts by the Line C O;

C O; that done, divide one of them Quadrants into 90 degrees, and the other into eight points of the Compass; that to be divided into 90 deg. must be first divided into three equal parts, and every one of them into three equal parts, (that is nine in all) and draw them to the third Circle inward, which will represent 90 deg. and so must be every one of them divided into ten equal parts; but 'tis best to divide them into two parts first for the fifths, and prick them, and then into five each, in all 90.

That to be divided into points of the Compass, is done as the Mariners Compass is: Now having a Scale of Wood before you gaged (as the Lines on the Scale on the Figure) take off B 10 and set it from R upon the Scale, then take off B 20 and set it from R, and so along till you come to 90 degrees; then take off every fifth degree in like manner, and divide them fifths, as you see in the Scale, so that every of the great divisions may contain ten of them: so likewise take off the points of the Compass and divide them into halves and quarters. Now this is called the Line of Chords, because 'tis taken like the string of a Bow or Arch, as B D is the String or Chord of 60 deg. and so of the points A F, is the Chord of 7 points; and so of the rest, B S is the tangent of the Arch B R.

The signe of any Arch is a Line let down from the place appointed in the Quadrent or Arch, to the Line that goeth through the Center perpendicularly, as D E is the signe of 60 deg. and so is taken off sweeping that Line. After that manner take off 10, and then 20, and so to 90 deg. and set them upon your Scale, dividing them as far as you can into ten parts, and that will be a Line of Sines.

There should be a Scale of equal parts, but that's what you will: commonly 6 of them are equal to 60 degrees of the Line of Chords, and so go forwards with them the whole length of the Scale, onely the first equal part you must divide into ten equal parts, that so when the greater parts be counted ten, the small ones will be (each) one; or if the great ones be one hundred (each) the small ones will be (each) ten; or if the great ones be one, the little ones will be (each) one tenth of a Unite: You may figure the great divisions 10, 20, and so along as far as they go.

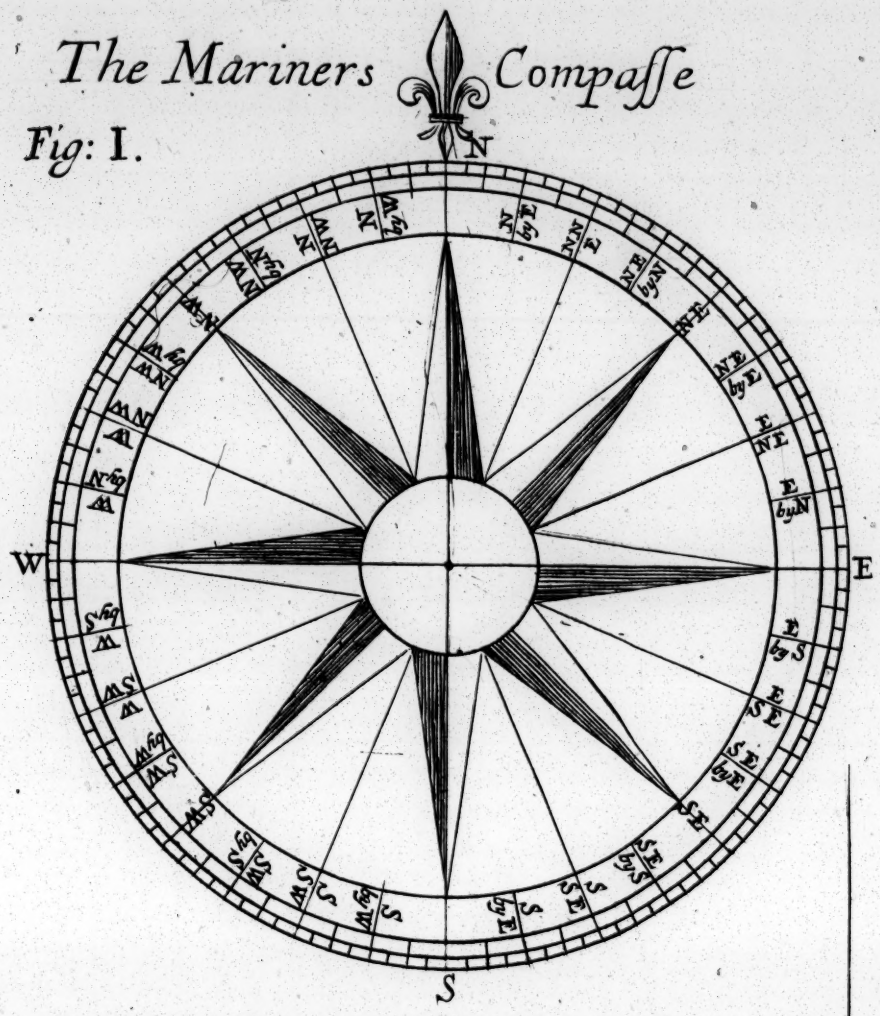
For sailing by *Mercator*'s (or the true Sea) *Chart*, it were necessary that you have a *Scale* which will shew you how many *Miles* will make a *degree* of *Longitude* in any *Latitude*; and there is a Line called a *Line of Longitudes*, which is commonly put upon *Mariners Plain Scales*: The manner how to project the same Line from this Scheme Fig. II. is thus:

Divide the semi-diameter of the Circle C O into six equal parts in the points G H I K and L, and through those points draw Lines, all parallel to the Diameter O B, as G M, H N, I O, K R, L P; this done, take with

your

The Mariners Compasse

Fig: I.



The Projection of y^e Mariners plaine Scale

Fig. II.

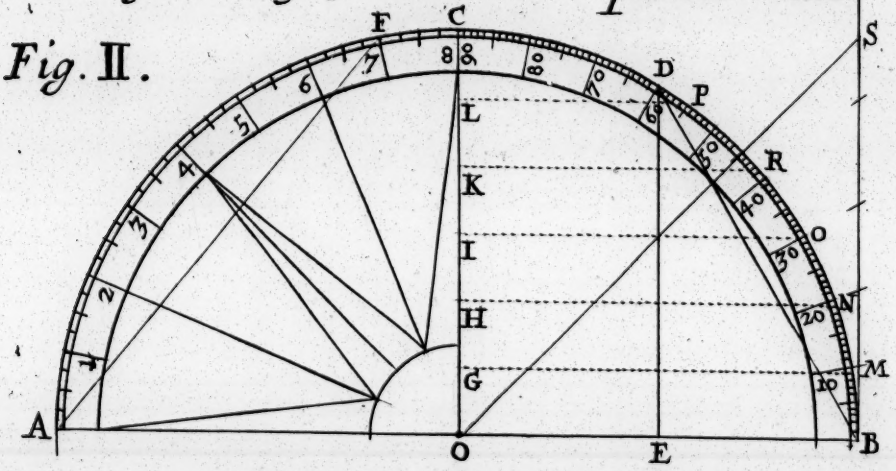
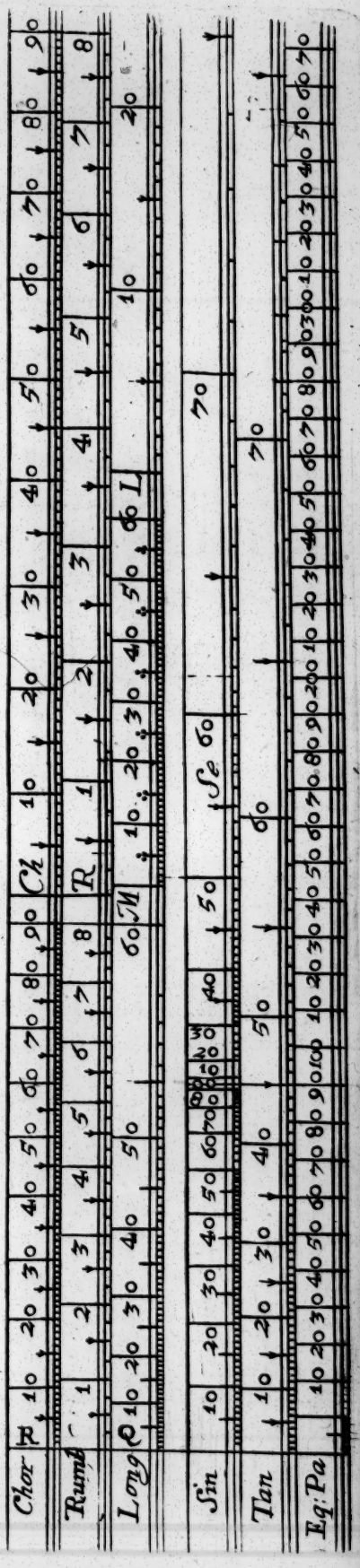


Figure III. *The Figure of the Plain Scale.*



Against Page 8.

your Compaſſes the diſtances from C, to the reſpective points M, N, O, R, P, and ſet thoſe diſtances upon the Line of Longitude on your Scale from Q to 10, 20, 30, 40, and 50, dividing that Line into ſix unequal parts, which muſt be (each of them) ſub-divided into ten other unequal parts, by dividing the ſpaces between O and G, G and H, *&c.* each into ten equal parts, and drawing Parallels through them, and transfering them from the limb of the Quadrant C R B, as you did the others. This Scale is of good uſe in keeping of a *Reckoning*, according to *Mercator*'s Sailing, in which the uſe of it ſhall be taught.

And to make this *Mariners Plain Scale* the more compleat (although Mr. *Collins* ſeems to have new plained this Plain Scale long ſince, in his Book ſo called) I would have added unto it the *Secants* and *Tangents* continued as far as the Ruler will permit: alſo two Lines of *equal parts*, of the ſame Radins with the Scales of *Chords*, *Sines*, and *Tangents*. All which additional Scales being of ſingular uſe in *Navigation*, in making of *Sea-Charts* both plain, and according to *Mercator*; as alſo in *projecting* of the *Sphere*, *Great Circle Sailing*, and reſolving of *Geographical* and *Aſtronomical Problems*, uſeful in *Navigation*; Examples of all which, ſhall be given in the following Treatiſe. I have therefore in Fig. III. diſpoſed the Lines upon the Ruler according to the beſt artifice that at preſent I could think upon.

CHAP. IV.

To Project the Sphere *for* 51 deg. 30 min. *of North Latitude, the Sun having North Declination* 18 deg. 00 min.

YOu are to take notice, that the Lines upon a *Plain Scale* are taken from a Circle, and reduced to ſtreight Lines, as was taught in the third Chapter: therefore it may be taken from a ſtreight Line, and ſet upon a Circle of the ſame ſemi-diameter. Now the ſemi-diameter of the Circle that makes any Scale, is juſt 60 deg. of the ſame Circle; ſo that you can never be at a loſs, for the Circle that made the Scale, any thing taken from the Scale, may be applied to the Circle, or the contrary.

Now to Project this *Sphere*, take 60 deg. from the Line of Chords, and upon the point O, as a Center, describe the Circle A E G K, which Circle represents the *Meridian* of the place, or that Circle that riseth from the North point of the *Horizon* at E, and goeth through the *Zenith* at G, to the South point of the same *Horizon* at E. Divide this Circle into four equal parts, by the Lines A E, and G K, then A E represent the *Horizon*; E the North point thereof, A the South point, G the *Zenith* right over us, O the *East* and *West* points of the *Horizon*, K the *Nadir* right under us; the Line G K is a great Circle that cuts the *Horizon* in the points of East and West, and is called the East and West *Azimuth*, because it comes through the *Zenith* and *Nadir*: S L represents the *Axis* of the World, or the *Axis* that the World turns upon; L the *North Pole*, S the *South Pole*; E S is the height of the North Pole above the Horizon, called the *Poles Elevation*; S A the depression of the *South Pole* under the Horizon; E I is the *Equinoctial*, and is always below the *Zenith*, as much as the Latitude is, and so is called the *Latitude*, for when you are under it, you are in no Latitude; F D is the *Tropick of Cancer*; B R is called the *Tropick of Capricorn*: These Lines are each 23 *deg.* 30 *min.* distant from the *Equinoctial*; one to the *Northwards*, the other to the *Southwards* of it, and represent the outmost bounds of the Suns *Declination* Northerly or Southerly, the Suns motion being always between them, carried about in the *Ecliptick-line* R D: the *Artick Circle* is L L, and is 23 *deg.* 30 *min.* from the *North Pole*; N N is the *Antartick Circle*, as far from the *South Pole*, and the spaces between them and the *Poles*, are called the *Frozen Zones*; and the spaces between them and the *Tropicks*, are called the *Temperate Zones*; and the spaces between the *Tropicks*, are the *Torrid* or *Burning Zones*. This may suffice for a description of the Imaginary Circles in the Sphere: all Lines that go through the Center, represent *Great Circles*, such as divides the Sphere into two equal Hemispheres. These things premised, we now come to the resolving of some *Astronomical Problems* by the *Projection*.

Fig. I.

CHAP.

CHAP. V.

Anno 1687. *Latitude Northerly* 50 deg. *Declination Northerly* 17 deg. 47 min. *being the* 23th *of* July, *I demand as followeth.*

		deg.	min.	
1.	THe *Meridian-Altitude* of the Sun	57	47	
2.	The Suns *heighth* at 6 of the Clock	13	32	
3.	The Suns *Azimuth* at 6 of the Clock	14	13	
4.	The Suns heighth being due *East* or *West*	28	22	
5.	The Suns *Amplitude* of *Rising* and *Setting* Northerly	28	24	
6.	The Suns place in the *Ecliptick* is 10 *deg.* of *Leo*	49	59	
7.	The Suns *Right Ascension*	46	29	

		ho.	min.	sec.
8.	The difference of *Ascension*	01	29	52
9.	The time of the Suns *Rising*	04	30	08
10.	The time of the Suns *Setting*	07	29	52
11.	The *length* of the *Day*	14	59	44
12.	The *length* of the *Night*	09	00	16
13.	The time of *Day breaking*	02	42	00
14.	The time of *Twi-light ending*	09	18	00
15.	The *continuance* of *Twi-light*	01	48	00
16.	The time of the Suns being due *East*	07	29	52
17.	The time of his being due *West*	04	30	08
18.	The *length* of the *Longest Day* and *Night* in that Lat.	16	10	00
19.	The *length* of the *Shortest Day* and *Night* in that Lat.	07	50	00

PROB. I.

To find the Meridian-Altitude of the Sun.

Fig. II. THe *Meridian-Altitude* of the Sun, is his heighth that day when he is upon the Meridian, or over the *South point* of the Compass, which is represented by A D. Fix your Compass in

A, and extend the other point to D, (the place where the Suns parallel of Declination cuts the Meridian;) and that diſtance apply to your Scale of Chords, and what number of degrees it falls upon the Scale, ſo high above the *South point* of the *Horizon* is the Sun that day at noon: 'Tis here 57 *deg.* 47 *min.*

PROB. II.

To find the Suns Heighth *at 6 of the Clock.*

WHere the Suns parallel of Declination cuts the *Axis* of the World, there is the Sun at 6 of the Clock; therefore Q T is the diſtance that the Sun is from the Horizon at that time: Take it off from Q, ſweeping the Horizon A H at T, and ſet it upon your Line of *Sines*, and ſo many degrees as it is there, ſo much is the Suns heighth at 6 of the Clock; I find it here to be 13 *deg.* 32 *min.* The reaſon that I did not apply it to the Line of Chords, is, becauſe 'tis a diſtance taken from a ſtreight Line, and ſo a *Sine*, as you may ſee by the Projection of the *Plain Scale.*

PROB. III.

To find the Suns Azimuth *at 6 of the Clock.*

THe Suns *Azimuth* at 6 of the Clock, is his neareſt diſtance from the Eaſt and Weſt *Azimuth*, and is taken from Q to W, ſweeping that Line: apply it to your Line of *Sines*, and ſo many degrees and minutes as it is, ſo much is the Sun from the *Eaſt point* of the *Compaſs* at 6 of the Clock. It is here 14 *deg.* 13 *min.*

PROB. IV.

To find the Suns Amplitude *of Riſing and Setting.*

THe Suns *Amplitude* of riſing and ſetting, is the number of degrees and minutes that the Sun riſeth from the *Eaſt*, or ſets from the *Weſt point* of the *Horizon*, and is of great uſe at Sea, to find the *Variation of the Compaſs* (for 'tis the true *Amplitude.*) Now to know it, fix one foot of your Compaſſes in the Horizon, at the place where the Sun riſeth (which is at P) and extend the other point to the Eaſt point of the Horizon, (which is at the center of the Sphere, at the

point

point ♈ and ♎) and apply it to your Lines of *Sines*, and it gives your desire. It is here in this case 28 *deg.* 24 *min.* and it is so much to the Northwards of the East, because the Sun hath North Declination.

Prob. V.

To find the Suns Heighth, *being due* East *or* West.

The Sun is over the East point of the Compass, when his parallel of Declination cuts the East and West *Azimuth* (as you may see in the *Scheme*) at G. Fix your Compasses at G, and open them to the center of the Sphere, and that distance apply to your Line of *Sines*, and it gives your desire. 'Tis here 28 *deg.* 22 *min.*

Prob. VI.

To find the Suns place in the Ecliptick.

The *Suns place in the Ecliptick*, is his neareſt distance from the place in the *Ecliptick*, that his parallel of Declination cuts it, to the next or neareſt Equinoctial point, which is S ♈: Take that distance off, and apply it to your Line of *Sines*, and it gives your desire. It is here 46 *deg.* 29 *min.* from the next or neareſt Equinoctial point.

But if you have a mind to measure these streight Lines by your Line of Chords, you may reduce your distances so taken into a Chord, thus: Take your distance, and from a place on the circumference of the *Sphere*, sweep some Lines that goeth through the Center, as here from X the Line X R sweeps the Horizon, and is a Perpendicular let fall to R upon it: Now X R is the *Sine* of the Arch, of which X A is the Chord of the same; so that if you take X A off, and apply it to your Line of Chords, it gives the same thing. And thus you may reduce a *Sine* into a *Chord*, or the *Contrary*; but for the Suns place, I refer you to *Fig.* IV. and for his *Right Aſcenſion* also.

PROB. VII.

To find the difference of Ascension.

Note, *That* 15 *degrees is one* hour *in time*, 15 *minutes of a* degree *is one* minute *of* time; *so that one* degree *is* 4 *minutes of* time.

THe difference of *Ascension* is the time between the Suns rising and 6 of the Clock, or how long the Sun riseth before or after 6 of the Clock; in this case he riseth before 6, for he riseth at P, and it is not 6 of the Clock till he comes to Q; so that the difference of *Ascension* is P Q, and is taken from a Line that is shorter than a Line that goeth through the Center, or (more properly) from a Circle that is lesser than a great Circle of the *Sphere*. Now in this case, your distance taken off must be extended to that Circle that your Scale was made by, which is the Meridian of the *Sphere*; and you may do it thus: Take half the length of the Line that your distance is to be taken off from, as here 'tis the parallel of the Suns Declination, (which is Q D) and fixing your Compasses in the Center of the *Sphere*, with that distance describe an Arch (from some Line that goeth through the Center) as the Arch 2 2; then take off the difference of *Ascension* P Q, and apply it as a *Sine* to that Arch, from some place in it, that it may just sweep the Line that goeth through the Center, as here it will from 3; then lay your Scale by the Center of the *Sphere*, and draw the short Line 3 4. Now 'tis apparent that the Arch 3 2 on the little Arch, is the same that the Arch 4 A is upon the great Arch: therefore 4 A taken off and applied to your Line of *Chords*, is the *difference of Ascension* in degrees and minutes, and I find it here to be 22 *deg.* 30 *min.* which converted into time, is 1 *ho.* 30 *min.* the *difference of Ascension in time*; so much (in this case) the Sun riseth before 6 of the Clock. The way to convert your degrees into time, is to multiply them by 4, and that brings them into minutes of time; and if the number of minutes of time exceed 60, divide your minutes by 60, and the Quotient will be hours, the remainder of the division will be *minutes*; if there be above 15 *min.* of a degree (besides the even degrees) adde it to your time for 1 *min.* if 30, for 2 *min.* of time, *&c.*

PROB. VIII, IX.

To find the time of the Suns Riſing, and the length *of the day.*

HAving found the difference of *Aſcenſion*, as before, look in the *Scheme*, and conſider whether it be before or after 6 of the Clock that the Sun riſeth at that time; I ſee in this Example it is before 6, ſo that then I conclude the Forenoon is longer than 6 hours, by all this *difference of Aſcenſion*: therefore adde it to 6 hours, and it gives the length of the Forenoon; and that doubled, is the length of the day, 14 *ho.* 59 *min.* 44 *ſec.* I ſaid before, that the Forenoon is longer than 6 hours, by the *difference of Aſcenſion*, why then ſubſtract the *difference of Aſcenſion* from 6 hours, and it gives the time of the Suns riſing, which in this Example is at 4 *ho.* 30 *min.* 8 *ſec.*

Likewiſe, if you adde the ſame *difference of Aſcenſion* to 6 hours, it gives the time of the Suns ſetting (which in this Example is at 7 *ho.* 29 *min.* 52 *ſec.*)

If you would find the length of the night, ſubſtract the length of the day from 24 hours, and it leaves the length of the night; which in this Example is 9 *ho.* 00 *min.* 16 *ſec.*

PROB. X.

To find the time of the Suns being due Eaſt *or* Weſt.

WHere the Suns parallel of Declination cuts the Eaſt and Weſt *Azimuth*, there the Sun is when he is over the Eaſt point of the Compaſs: Then from 6 of the Clock to that place which is ſo cut by the Suns parallel of Declination (which is Q G) take off and extend it to the Chord of your Circle the Scale was made by (as you did the *difference of Aſcenſion*) and the number of degrees and minutes convert into time, and adde it to 6 hours, and it makes the time of the Suns being due Eaſt that day. I hope you ſee the reaſon why it muſt be added: it's becauſe 'tis after 6 (before its over that point) I find it to be in the Example 22 *deg.* 30 *min.* after 6 of the Clock, that is, at 7 a Clock 30 *min.* Now for the time of the Suns being over the Weſt point of the Compaſs, that muſt be as much before 6 hours in the afternoon, and therefore ſubſtract it from 6 hours, and you have your deſire. 'Tis here 4 *ho.* 30 *min.*

PROB.

PROB. XI.

To find the length of the longest Day in that Latitude, or shortest Day or longest Night, or shortest Night.

IN any North Latitude, the Suns parallel of Declination must be the *Tropick of Cancer*, to make the longest day. Now the *difference of Ascension* that day is *a b*; take it and set it off after the manner I did before, using the *Tropick* as I did the parallel of the Suns Declination, and extend it to the Circle of the Scale, and so many degrees and minutes is the *difference of Ascension* that day; it is 30 *deg.* 20 *min.* which converted into time, is 2 *ho.* 50 *min.* and that added to 6 hours, gives the length of the forenoon; which doubled, is the length of the longest day in that Latitude; equal to which, is the longest night: again, that substracted from 24 hours, leaves the length of the shortest night, which is equal to the shortest day.

PROB. XII.

To find the time of Day-breaking, and the time of Twi-light ending.

IT is the Opinion of all *Astronomers*, that the day breaks when the Sun is 18 degrees under the Horizon: therefore take 18 degrees from the Line of Chords, and under the Horizon set it off, and draw a Line parallel to the Horizon (as the Line 8 8;) next, see where the parallel of the Suns Declination cuts the parallel of 18 degrees, and measure from thence to 6 of the Clock, and convert the degrees and minutes into time, and substract it from 6 of the Clock, and it gives you the time of day-breaking. It's here 2 *ho.* 42 *min.*

If you would find the time of Twi-light ending, adde the same to 6 hours, and it gives the time of Twi-light ending; which is 9 *ho.* 18 *min.* in the evening.

PROB. XIII.

To find the continuance of Twi-light.

TAke 18 deg. Q (the time between the Suns giving light and 6 a Clock) and convert it into time; and from that, if you substract

ſtract P Q the *difference of Aſcenſion*; the remainder is P 18, the continuance of Twi-light; which is in this Example 1 *ho.* 48 *min.*

PROB. XIV.

To divide the Ecliptick *into* Signes, *by the Line of* Sines.

NOte, That there be 12 *Signes*, and they divide the Ecliptick Line, or Circle, into 12 equal parts. Now becauſe the Ecliptick is 360 degrees, therefore 30 degrees is contained in each *Signe*, (12 times 30 being 360.) The Characters of the *Signes* are theſe following.

Aries,	*Taurus.*	*Geminy.*	*Cancer.*	*Leo.*	*Virgo.*
♈	♉	♊	♋	♌	♍

Libra.	*Scorpio.*	*Sagittarius.*	*Capricornus.*	*Aquarius.*	*Piſces.*
♎	♏	♐	♑	♒	♓

In North Latitude 50 deg. 00 min. *Declination Northerly* 17 deg. 47 min.

Fig. III. AS I ſaid before, there be 30 degrees to every *Signe*, take off 30 degrees from your Scale of Chords, (if you have no Line of *Sines*) and reduce it into a *Signe*, and ſet it from the center of your *Sphere* on both ſides upon the Ecliptick, as here to ♉, and then ſet off 60 deg. which is two *Signes*, then 90 deg. which will be to the edge of the Circle, and is three *Signes*, and mark them, thus: From ♈ to ♋, the firſt three; and back from ♋ to ♎; from that to ♑; and laſtly, from that to ♈: and thus the *Ecliptick* is divided into twelve parts, or *Signes*. For though a plain ſuperfices doth not demonſtrate the Lines to be Circles, yet you muſt conceive of them ſo: for you know all Lines drawn upon a Circle, muſt be ſo, or parts of Circles. Thus you muſt conceive of this Line to be forwards and back again, the whole Great Circle called the *Ecliptick*.

PROB. XV.

Latitude 50 deg. 00 min. *Northerly, Declination Northerly* 17 deg. 47 min. *I demand the Suns place in the Ecliptick, and his Right Ascension the* 23th *of* July 1687.

Fig. IV. THe Suns place in the Ecliptick (as I said before) is his nearest distance from the next Equinoctial point in the Ecliptick Line, (or to the nearest place where the Equinoctial and the Ecliptick intersect one another) which is at ♈ from B (the place in the Ecliptick;) so then take ♈ B off, and apply it to your Line of *Sines*, or (if you have no Line of *Sines*) extend it to a Chord, and apply it to your Line of Chords.

The Suns Right Ascension is ♈ C, equal to B D; but to measure D B, take half the length of the Line R O, which is D O, and describe the Arch L P, and take D B and set it a *Sine* upon the Arch L P, and it measures to L, (the *Sine* F L.) Lay your Scale from the center of your Circle to L, and draw the Line L N to the edge of the circumference; that done, take N K, and apply it to the Line of Chords, and as many degrees and minutes as it is, so many degrees and minutes is the *Suns Right Ascension that day:* and thus you may extend any little Circle to the Circle your Scale is made by, or the contrary; for L P is the same quantity upon the little Circle, that N K is upon the greater. I find the Suns place here to be 49 *deg.* 59 *min.* Right Ascension is the number of degrees and minutes that come from *Aries* to the Meridian, which the Sun or Star, as here ♈ C, goeth along, as D B doth, and the Arch or Meridian B C, would come to the Meridian at O S at the same time.

PROB. XVI.

November 10. 1687. *in North Latitude* 50 deg. 00 min. *Declination Southerly* 17 deg. 47 min *I demand, as followeth.*

		deg.	*min.*
1.	THe *Meridian-Altitude* of the Sun	22	30
2.	The Suns *Amplitude* of rising and setting	28	24
3.	The Suns *heighth* at 6 of the Clock not up by 46′		
4.	The Suns *heighth*, being due *East* or *West* not up by C ♈		
5.	The Suns *Azimuth* at 6 of the Clock	14	13

6. The

		deg.	*min.*
6.	The Suns place in the *Ecliptick*, is in 28 *deg.* 59 *min.* of ♏	48	59
7.	The Suns *Right Aſcenſion*	46	29
		ho.	*min.*
8.	The *difference of Aſcenſion*	01	30
9.	The time of the Suns *riſing.*	07	30
10.	The time of the Suns *ſetting*	04	30
11.	The length of the *day*	09	00
12.	The length of the *night*	15	00
13.	The time of the Suns being due *Eaſt*	04	31 $\frac{2}{15}$
14.	The time of the Suns being due *Weſt*	07	29 $\frac{13}{15}$
15.	The time of *day breaking*	05	42
16.	The time of *Twi-light ending*	06	18
17.	The *continuance* of *Twi-light*	01	48
18.	The length of the *longeſt day* or *night* in that Lat.	16	10
19.	The length of the *ſhorteſt day* or *night* in that Lat.	07	50

For the performance of theſe things, I project a *Sphere* for the Latitude given, and ſet my parallel of Declination to the ſouthwards of the Equinoctial, (according to the Propoſal) and it is repreſented by R O; and ſo proceed to meaſure all thoſe things required. And, Fig. V.

Firſt, For the *Meridian-Altitude* of the Sun, it is A O; take it off, as before hath been ſhewed, I find it here 22 *deg.* 30 *min.*

Next, for the *Suns Amplitude* of *riſing* and *ſetting*, it is L ♈; take it off, as hath been ſhewed before, and ſet it down: in this Example it's 28 *deg.* 24 *min.* and ſo much the Sun *riſeth* to the *ſouthwards* of the *Eaſt.*

For the Suns *heighth* at 6 of the Clock, look and find where the *Suns* parallel of Declination cuts the Axis of the World, and there is 6 of the Clock, namely, at 6. Now you ſee the Sun is not up at 6 of the Clock, by the whole *difference of Aſcenſion* 6 L.

For the Suns *heighth* being due *Eaſt* or *Weſt*, the Sun is at C, when he croſſes the Eaſt point of the Compaſs, and ſo is not up.

The Suns *Azimuth* at 6 of the Clock, is B 6; take it off (as in the Example of North Declination before) 'tis here 14 *deg.* 13 *min.*

The Suns *place* in the *Ecliptick* is F ♈, and is taken off, as is ſhewed in in the former Example of that nature: I find it to be here 28 *deg.* 59 *min.* of ♏.

The Suns *Right Aſcenſion* is 6 F, equal to S ♈, and is taken off, as I have ſhewed in the Example before; and find it 46 *deg.* 29 *min.*

The *difference of Aſcenſion* is 6 L, and is taken off, as in the Example done before of this nature: It is here 1 *ho.* 30 *min.*

The time of the Suns *riſing* is after 6 of the Clock the whole *difference of Aſcenſion*, ſo that being added to 6 hours, makes the time of the Suns riſing: It's 7 *ho.* 30 *min.*

For the time of the Suns *ſetting*, ſubſtract it from 6 hours, and you have the Sun to ſet at 4 *ho.* 30 *min.*

For the *length* of the *day* (ſee in the laſt done) the length of the afternoon, and double that, and 'tis the length of the day: it is 9 *ho.* 00 *min.* This ſubſtracted from the whole 24 hours, muſt leave the length of the night, which is 15 *ho.*

For the time of the Suns being due *Eaſt*, take C 6 and convert it into time, and ſubſtract it from 6 of the Clock, and it gives the time of the Suns being due *Eaſt*, which is 4 *ho.* 31 *min.* 8 *ſec.* (for you ſee the Sun cuts at the *Eaſt* and *Weſt Azimuth* ſo long before 6 of the Clock.)

For the time of the Suns being due *Weſt*, adde the ſame C 6 (laſt found) to 6 hours, and it makes the time of his being due *Weſt*, which is in this caſe 7 *ho.* 29 *min.* 30 *ſec.* and the reaſon is plain, foraſmuch as the Sun is due *Eaſt* before 6, ſo much he is due *Weſt* after 6 in the evening.

The time of *Day breaking* is • 6; take it off and convert it into time, and ſubſtract it from 6 hours (becauſe 'tis before 6) and it gives your deſire, 5 *ho.* 42 *min.* adde it to 6 hours, and it gives the time of Twi-light ending, which is 6 *ho.* 18 *min.*

The continuance of Twi-light is 6 L; take it off (as hath been before ſhewed) and convert it into time, its 1 *ho.* 48 *min.*

For the *longeſt day* in that Latitude, take B E for the *difference of Aſcenſion*, and (when converted into time) adde it to 6 hours, and that doubled, is the *length of the day*; that ſubſtracted from 24 hours, is the *length of the ſhorteſt day*, or night; (the longeſt day is equal to the longeſt night) but if you will for the *length of the ſhorteſt day*, you may take Q Q for the *difference of Aſcenſion*, and convert it into time, and ſubſtract it from 6 hours, and it gives the length of half the *ſhorteſt day*, which doubled, is the length of the ſhorteſt day or night.

Latitude 50 deg. 00 min. *Southerly, Declination Southerly* 17 deg. 47 min. *I demand, as before.*

Fig. VI. I Hope this will not ſeem tedious, becauſe it may be difficult for a Learner to underſtand it ſo well without it. To erect a *Sphere* of this nature, you muſt conſider the *South Pole* is now elevated, and therefore ſet your Latitude from the South point of the Horizon upwards for the elevation of the *South Pole*, as H I; the ſame diſtance ſet from the Zenith towards the North point of the Horizon upon the Meridian for the Equinoctial, as E N; the ſame from the North point of the Horizon A, downwards for the *North Pole*, as A B, and draw the Axis of the World I B, and the Equinoctial N E, then ſet off the *Tropicks*, and draw them as hath been taught already, and alſo the *Ecliptick*.

The *Sphere* thus finiſhed, we proceed to the Queſtions, which I onely intend to ſhew where they muſt be taken off, and leave the practice of it to you.

1. The *Meridian-Altitude* of the Sun, is above the North Pole of the Horizon A M.

2. The Suns *Amplitude* of *riſing* and *ſetting*, is P ♈, to the ſouthwards of the Eaſt.

3. The Suns *heighth* at 6 of the Clock, is 6 Z.

4. The Suns *Azimuth* at 6 of the Clock, is 6 S.

5. The Suns *heighth*, being due *Eaſt* or *Weſt*, is S ♈.

6. The Suns place in the *Ecliptick*, is L ♈.

7. The Suns *Right Aſcenſion*, is L 6.

8. The *difference of Aſcenſion*, is P 6, after the Sun is riſen.

9. The *length of the Day* is longer than 12 hours, by double the *difference of Aſcenſion*.

10. The *length of the Night* is the length of the day ſubſtracted from 24 hours.

11. The time of the Suns *riſing*, is P 6, before 6 a Clock.

12. The time of the Suns *ſetting*, is as much after 6 a Clock.

13. The time of the Suns being due *Eaſt*, is 6 S, added to 6 hours.

14. The time of the Suns being due *Weſt*, is the ſame ſubſtracted from 6 hours.

15. The *longeſt day* is found by O 6, for the *difference of Aſcenſion* that day.

16. The

16. The *longest night* is equal to it; the shortest day and night is that substracted from 24 hours.

PROB. XVII.

To find the Suns Azimuth at any time of the day in any Latitude.

THese foregoing are the chief uses of this *Projection* in *Astronomy* that can be performed by the *Plain Scale*, which do not require the *Altitude* of the Sun; but this following *Problem* (viz. *to find the Suns Azimuth at any time, as well as at noon, Sun rising, or being due East or West*) being so general, and of such use in the finding of the true *Meridian*, and from thence the *Variation of the Compass*; that I thought good to shew you how easily and exactly it may be done by the Line of Chords onely: and for that end, I shall refer you to Fig. III. in the fourteenth *Problem* of this *Chapter*; where the *Sphere* is projected for the *Latitude* of 50 *deg. North*, and for the Suns *Declination* 17 *deg.* 47 *min. North.* In which Scheme, H Z O N represents the *Meridian*, H O the *Horizon*, Z N the *Azimuth* of *East* and *West*, P the *North Pole*, S the *South Pole*, Æ, ♈ ♎, œ, the *Equinoctial*, ♋ ♋ the *Tropick* of *Cancer*, ♑ ♑ the *Tropick* of *Capricorn*, and ♋ ♑ (with the rest of the *Signes* upon it) the *Ecliptick*.

Fig. III.

The Scheme being thus prepared, take 50 *deg.* the Latitude, from your Scale of Chords, and set it upon the Meridian from Z to Æ, from N to œ, also from O to P, and from H to S; and draw Æ œ for the *Equinoctial*, and P S for the *Axis of the World*---Then, the Suns *Declination* being 17 *deg.* 47 *min.* Northward, take that out of your Scale of Chords, and set it upon the *Meridian* from Æ and œ, to D and D, towards P the *North Pole*, (because the Declination was Northward) and draw the Line D D for the *Parallel* of the *Suns Declination* or *Course* for that day.----Also, take 35 degrees (the Suns *Altitude observed*) and set it from H to L, and from O to L, drawing the Line L L for the Line of the Suns *Altitude*, cutting the Line D D in the point ⊙, (which is the place in the Heavens in which the Sun was at the time of observation.) ----This done, take half the length of the Line L L, *viz.* ⊙ L, in your Compasses, and setting one foot in the Center, noted with ♈ and ♎, describe the Circle C A F; and from the point ⊙ erect a Perpendicular ⊙ A, cutting the Circle last described in the point A.----Lastly, lay a Ruler from the Center at ♈ and ♎, to the point A, and draw the Line A B, and your work is ended.

And

Fig. I.

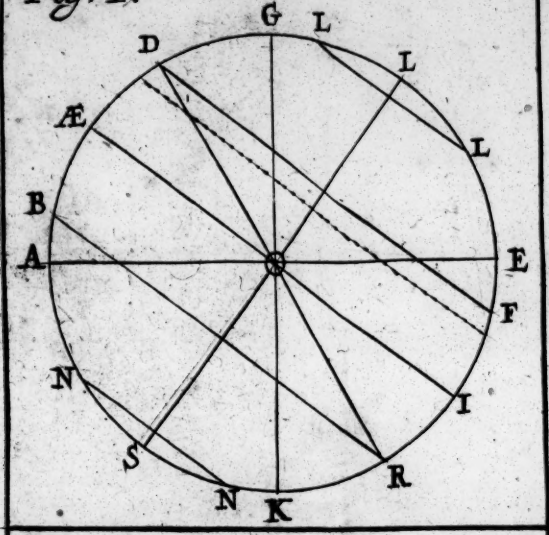


Fig. II.

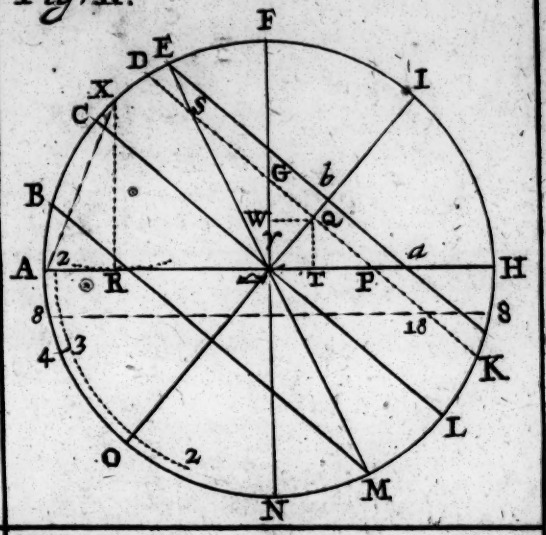


Fig. III.

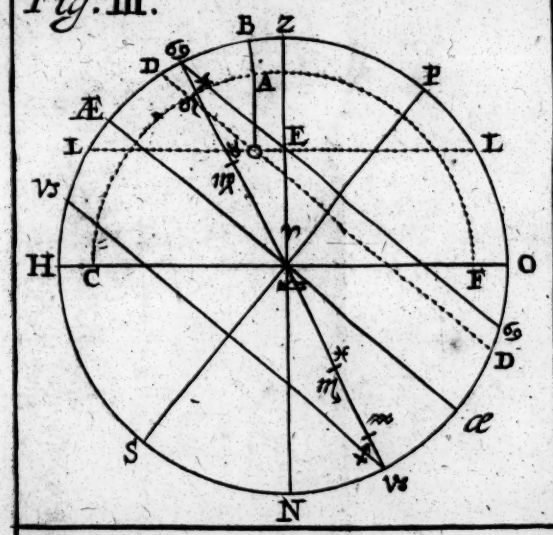


Fig. IV.

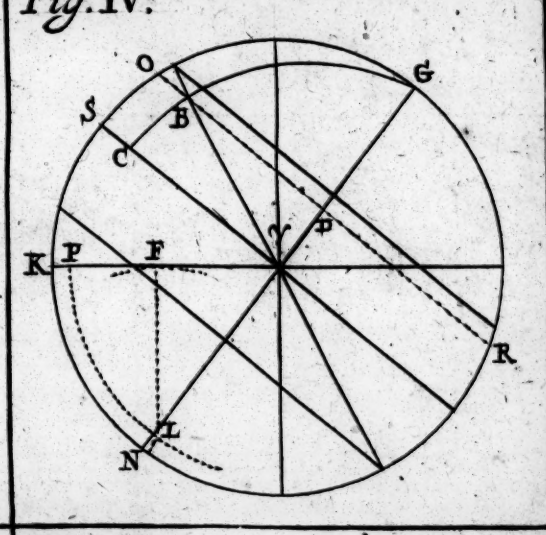


Fig. V.

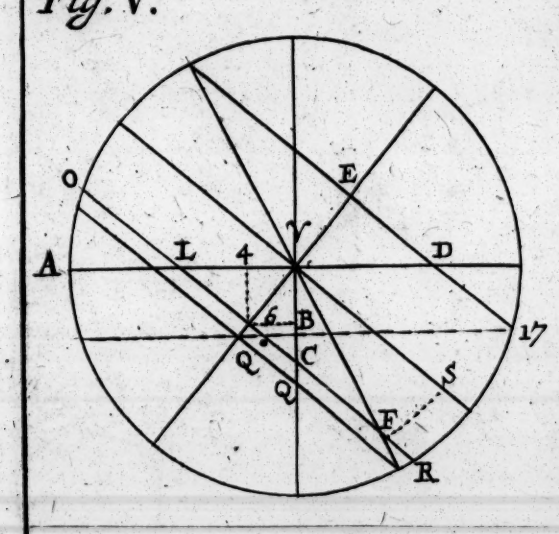
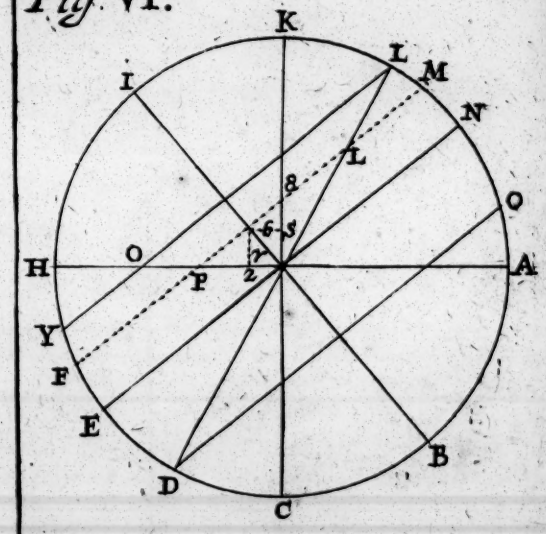


Fig. VI.



Against Page 22.

And then,

H B measured upon the Scale of Chords, shall be the Suns *Azimuth* from the *South*, and shall be (in this Example) 77 *deg.* 8 *min.*

B Z the Suns *Azimuth* from the *East* or *West*, and shall be 12 *deg.* 52 *min.*

B O shall be the Suns *Azimuth* from the *North* part of the Meridian, and measured upon your Scale of Chords, shall contain 102 *deg.* 52 *min.*

This last *Problem* is of excellent use in *Navigation*, for that you may thereby find the *Variation of your Compass* at any time of the day, as well (nay better) than by a *Meridian-Altitude.*

Many more Problems *in* Astronomy, *and also in* Geography, *may be performed by this* Projection; *but let these suffice, till I shew you farther Uses of this Scale in other* Projections *of the* Sphere *in* Plano.

The Use of the GLOBES.

CHAP. VI.

The Use of the Terrestial Globe.

A Globe is an Instrument so well known, that it will be but lost time to express what its Materials are; and therefore I shall onely touch at that in the Use of it, as followeth in several Problems.

PROB. I.

Having the Latitude of any place given, to set the Globe to it.

WIthin the brazen Circle the whole Globe turns (which is called the *Graduated Meridian*) and is divided from the Poles or Axel-trees thereof, each way into 90 degrees. Now to set the Globe to any Latitude proposed, turn the Meridian in the Frame, till the degrees that you would set him to, cuts with the *Horizon* of the Globe, (which

(which is the flat round Frame of Wood in which the brazen *Meridian* turns) ; if the Latitude be *Northerly*, let the *North Pole* be elevated from the *Horizon*; if it be *South Latitude*, let the *South Pole* be elevated, and so it's set right (and if you set the *Meridian* due *North* and *South*) it represents (in either Globe) the true standing of the Heavens or Earth.

Prob. II.

To find the Latitude *of any place upon the Globe.*

LOok on the Globe for the *place*, and turn the whole body till that place comes under the *Graduated Meridian*, and the degree that falls upon it, is the *Latitude* of that place.

So if you turn it for the *Lizard* (and the Globe be made true) you will find the degree on the brass Meridian over it to be 50 *deg.*

Prob. III.

To find how two places bears one from the other.

TO do this, there is a Quadrant of Altitude which is to be fastened upon the brazen Meridian, and to be taken off at pleasure: set the Globe to the Latitude of one of the places, then turn the body till that place comes under the brazen Meridian, and screw on the *Quadrant of Altitude*, then turn it so that it may cut directly over the other place, whose bearing you would know, and see upon what degree of the Horizon the same edge cuts, for that is the bearing of these places one from the other, as was required.

Prob. IV.

To find the distance between two places.

FOr this, suppose the Quadrant of Altitude set over one of the places given on the brazen Meridian, turns it (as it was directed in the last Example) over the other, and to the number of degrees that is between them (on that quadrant) is the thing required.

PROB.

PROB. V.

To find the Longitude of any place.

TUrn the place whose Longitude is required, to the *Graduated Meridian*, and at the same time the Meridian will cut the Equinoctial in the degree of Longitude that place lies in; for the Equinoctial is divided into degrees.

CHAP. VII.

The Use of the Cœlestial Globe.

PROB. I.

Having the day of the Month given, to find the Signe and degree of the Ecliptick the Sun is in.

ON the wooden Horizon is a Kalendar; look in it for the day of the month, and right against it is the Signe, and the degree of that Signe, the Sun is in.

PROB. II.

To find the Amplitude of the Suns rising or setting.

BRing the Suns place in the Ecliptick, upon the Globe, to the Horizon, and count the degrees upon the Horizon between that and the Equinoctials, (cutting of it, and you have your desire) for where the Equinoctial cuts the Horizon, there is the East or West points of the Horizon.

PROB. III.

To find the time of the Suns rising and setting.

Note, *Upon the North Pole of the Globe there is a brass Circle with an Index that turns round upon it; this Circle is divided from* 12 *a Clock at noon, to* 12 *a Clock at night; and so from* 12 *a Clock at night, to* 12 *a Clock at noon, still forwards, the same way for the hours of the day and night.*

NOw to place the Index of the Hour-circle for any day of the year, you must set it to 12 on the upper edge of the Hour-circle; then is the Hour-circle rectified.

Now to know the time of the Suns rising, set the Globe to the Latitude that you are in, and look in the Ecliptick for the degree of the Signe the Sun is in, and, before you place the Index at 12 a Clock, turn that degree to the graduated brass Meridian, and keeping of it there, set the Index to the hour of 12 on the upper edge of the Hour-circle, then turn the Globe till the degree of the Suns place in the Ecliptick cut the East side of the Horizon. (Now the Index will turn with it upon the Hour-circle, and point to the hour of the Suns rising) or if turned to the West side of the Horizon, it will shew the time of the Suns setting.

PROB. IV.

To find the Declination, having his place given.

LOok for the Suns place in the Ecliptick, and turn the degree of his place to the graduated brazon Meridian, and so many degrees as is between that and the Equinoctial (on the Globe) so many degrees is the Suns Declination either Northerly or Southerly, according as the Signe is that the Sun is in.

PROB. V.

To find the Suns Meridian-Altitude any day.

LOok for the Suns place in the Ecliptick (as hath been shewn) and turn that degree to the brazon Meridian, then see how many degrees

degrees is between that and the Horizon, and ſo much is the Suns Meridian-Altitude that day.

PROB. VI.

To find the Altitude of the Sun any hour of the day.

SEt the Globe to the Latitude, then find the Suns place, and ſet the degree of the Suns place to the brazen Meridian; alſo ſet the Index to 12 of the Clock on the Hour-circle, then turn the Globe till the Index cuts the hour you would know his heighth at, and ſo let it ſtand till you have ſcrued on the Quadrant of Altitude to the brazen Meridian, in that part of it that is the Zenith (as the Globe now ſtands) and turn it ſo as you may cut the Sun in the Ecliptick; and ſo many degrees as is between the Suns place and the Horizon on that Quadrant of Altitude, ſo high is the Sun at that time.

PROB. VII.

To find the hour of the day by the Globe.

WIth a Quadrant, or other Inſtrument, take the Altitude of the Sun, and then this is but the converſe of the former: for having the Globe ſet to the Latitude, and the Index rectified, and the Suns place under the brazen Meridian, and the Quadrant of Altitude ſcrued on at the Zenith, turn the Globe ſo that the Suns place may cut that Altitude on the Quadrant, and then will the Index point out the hour of the day upon the Hour-circle.

PROB. VIII.

To find the Meridian-Altitude of a Star, or his heighth at any time of the night.

YOu have the Stars placed in the Cœleſtial Globe, ſo that you may ſee how to turn the Star to the brazen Meridian, better than the Suns place in the Ecliptick, and then proceed as you did in the caſes of this nature about the Sun.

PROB. IX.

To find the Right Ascension and Declination, as also the Oblique Ascension of the Sun or Star in any Latitude.

WHen you have rectified the Globe, bring the Suns place to the Meridian under the Horizon, and the degree of the Equinoctial that comes with it to the Meridian, is the Right Ascension.

Note, *If they will reach no part of the Meridian under the Horizon, they have no Right Ascension.*

If you would find the Oblique Ascension bring its place to the East side of the Horizon, and where the Horizon cuts the Equinoctial, is the *Oblique Ascension* of either Sun or Star.

If you would find the *Oblique Descension*, bring the Suns place to the West side of the Horizon, as you did the other to the East side, then work as before.

PROB. X.

To know what Stars are above the Horizon at any time of the day or night.

PLace the Globe in a true position, and then if you would know (in the day-time) what Stars are up, or above your Horizon, first take the Altitude of the Sun, and turn about the Globe till you bring the Suns degree or place to the Altitude taken; (on the Quadrant of Altitude screwed to the Zenith) stay the Globe there, and you will see all the Stars that are above the wooden Horizon represented unto you.

PROB. XI.

To know the time of night by the Globe.

TAke the Altitude of some known Star, then rectifie the Index of your Hour-circle according to the day of the month, then turn the Globe till you make the Star (taken) come to agree with, or cut upon the Quadrant of Altitude, at that degree on it that the Star was the

high, and at the ſame time, the Index on the Hour-circle will point to the time of night.

If the Star be paſt the Meridian, turn the Quadrant of Altitude to the Weſtwards of the Meridian; but if the Star be riſing, to the Eaſtward of the ſame.

Theſe things may be wrought upon the Globe, and divers others, but not with that exactneſs as by thoſe other ways that I have treated of, but this is a good demonſtration of them ways.

Thoſe that deſire farther inſtruction in the Uſe of the Globes, may make uſe of Mr. *Leybourn*'s *Introduction to Aſtronomy & Geography*; in which Book they may be fully ſatisfied in all the Problems thereof. And ſuch as deſire, may be furniſhed with Globes (of all ſorts) Spheres, Maps, Sea-Plats and Charts for all Navigations, at Mr. *Robert Morden*'s Shop in *Cornhill*, at the ſigne of *Atlas*, near the *Royal Exchange*, *London*.

The End of the Uſe of the Globes.

CHAP. VIII.

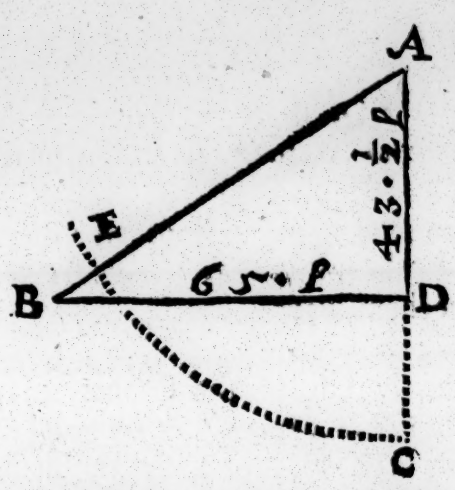
Propoſitions of Plain Sailing, performed by the Plain Scale.

Courſe *and* diſtance *run, being given, to find the* difference *of* Latitude *and* departure *from the* Meridian.

Queſt. 1.

Admit I ſet from the Lizard, *lying in the Latitude of* 50 deg. *(North) and ſail South Weſt by Weſt* 78 deg. *I demand what* Latitude *I am in, and my* departure *from my* Meridian?

TAke notice, that the *difference of Latitude* is the *Northing* or *Southing* that is made upon any given *Courſe*; and that the *Departure* from the *Meridian* is the *Eaſting* or *Weſting* that is made upon the



the ſame *Courſe*. Now to anſwer this Queſtion, I firſt propoſe to my ſelf the Eaſt and Weſt, North and South parts of my Book; and I always account the upper part of my Book to be *North* from me, and then conſequently *South* will be to me, and *Weſt* will be to the *left hand*, *Eaſt* will be to the *right*; ſo that D A is a *North* and *South*, and D B an *Eaſt* and *Weſt* Line. Theſe things premiſed, Firſt draw A D, and take off 60 deg. from your Scale of Chords, and from A as a center, deſcribe the Arch C E, and take five points froms your Scale of Points; and ſet upon that Arch from the South at C, to E (becauſe your Courſe is five points to the Weſtwards of the South) then from C by E draw the Line B A (which raingeth South Weſt by Weſt) and ſet off your diſtance run, which is given you, 78 leagues from A (it reacheth to B) there then muſt your Ship certainly be, becauſe B A is a South Weſt by Weſt Line, and 78 leagues from the place you ſet. Laſtly, let fall the Line A D Perpendicular to B D, and ſo you have the Triangle A B D. Now 'tis demanded what Meridian-diſtance you have made? Why you ſee the Eaſt and Weſt Line D B is your Departure or neareſt diſtance from the Meridian or North and South Line you ſet from, and A D is your *difference of Latitude* you have made to the Southwards of the place you ſet from; take them off, and ſet them on your Scale of Leagues, and ſo many leagues as each is, ſo much is your *difference of Latitude and Departure*.

The *Departure* from the *Meridian* B D is 65 leagues.
The *difference of Latitude* is A D $43\frac{1}{2}$ leagues.

Now to know what Latitude I am in, I conſider I am to the Southwards of the place I ſet from $43\frac{1}{2}$ leagues, and therefore in a leſs Latitude than I was, becauſe the Latitude I ſet from is *Northerly*; therefore I convert my $43\frac{1}{2}$ leagues, the *difference of Latitude*, into degrees and minutes, by multiplying my difference of Latitude by 3, (becauſe they are leagues) and it gives the minutes of diſtance (which is 229 *min.*) that divided by 60 (becauſe 60 minutes makes a degree) gives the degrees in the quotient, and the minutes is the remainder of the diviſion, which is 2 *deg.* 9 *min.* This ſubſtracted from the Latitude I ſet from, leaves the Latitude I am now in, which is 47 *deg.* 51 *min.* I'll be briefer in the reſt.

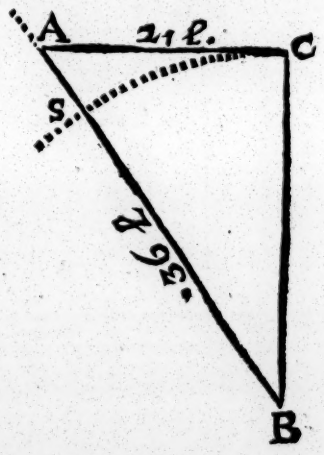
Courſe

Course *and* difference of Latitude *given, to find the* distance *run, and* departure *from the* Meridian.

Queſt. 2.

Admit I ſet from a place that lieth in North Latitude 32 deg. 20 min. *and ſail* North Weſt and by North, *till I come into the* Latitude *of* 33 deg. 50 min. *I demand my* diſtance run, *and* departure *from my* Meridian.

TO anſwer this Queſtion, firſt draw a North and South Line, and I draw it towards the right hand in my Book (becauſe there may be room for the Courſe) this done, towards the South end of it I propoſe the Port I ſet from to be (as at B, and from B (as a center I deſcribe an Arch of 60 degrees (taken from my Scale of Chords) and upon it ſet three points (as hath been ſhewed in the laſt Example) it being my Courſe North, three points to the Weſt, as C S upon the Arch of 60 degrees, and draw the Line B A at pleaſure by S; I ſay then, the Ship is ſomewhere in that Line: I look upon the Queſtion and find that the Ship ſailed from the Latitude of 32 *deg.* 20 *min.* into the Latitude of 33 *deg.* 50 *min.*. I ſubſtract the leſſer Latitude from the greater, and ſo have my difference of Latitude which the Ship hath made: It's here 1 *deg.* 30 *min.* or 30 leagues. This difference of Latitude ſet upon the North and South Line from the Port I ſailed, which is B, and it reacheth to C; (the reaſon I ſet it to the Northward, is, becauſe I ſailed more Northerly than I was) from C raiſe a Perpendicular or Weſt Line (becauſe the Ship ſails to the Weſtward) and where that cuts the range of the Ship, which is at A, there muſt the Ship be: ſo then A B is the *diſtance run*, and A C the *departure* required; take them off, and apply them to your Scale of Leagues.



A C is the departure 21 leagues.
B C is the diſtance run 36 leagues.

The like is to be underſtood of any other Queſtion of this nature.

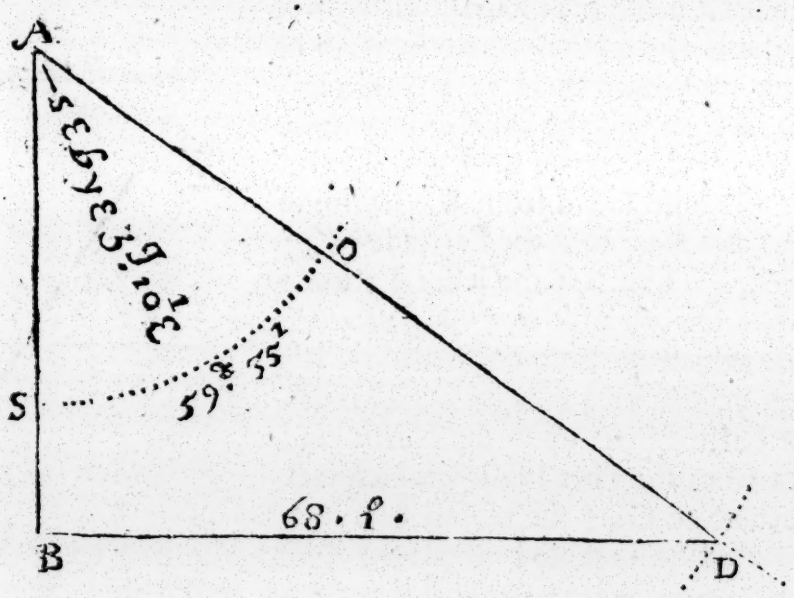
Difference

Difference of Latitude *and* diſtance run *given, to find the* Courſe *and* departure *from the* Meridian.

Queſt. 3.

Admit I ſet from a Head Land *which lieth in South Latitude* 40 deg. *and ſail upon ſome point between the* South *and the* Eaſt, 79 *leagues, till I alter my* Latitude 2 *degrees or* 40 leagues; *I demand my* Courſe *made good, and* departure *from the* Meridian.

FOr the doing this, I firſt draw a North and South Line, and in it propoſe the place the Ship ſets from. The North and South Line is A B; the place the Ship ſets from let be A: ſet your *difference of Latitude*, which is 40 leagues, from A, and it reacheth to B; from B raiſe a Perpendicular, and draw it at pleaſure, as B D; laſtly, take the diſtance run, and fixing one foot of your Compaſſes in A, croſs the Eaſt



and Weſt Line with the other, and where they interſect, is the place where the Ship is, which here is at D; draw the ſide A D to that point of their interſection; and meaſure D B, and the number of leagues is the departure from the *Meridian* that the Ship hath made. Then to know her Courſe made good, take an Arch of 60 degrees from your Scale, and making the place you ſet from the Center, deſcribe the Arch S O, as here (from A the Center); that done, take

off

off S O, and apply it to your Line of Chords, and as many degrees as it gives, ſo many degrees hath the Ship ſailed to the Eaſtwards of the South. If it were demanded what Latitude you are in, you muſt adde it to the Latitude you ſet from (becauſe you are in a South Latitude, and have gone to the ſouthwards): It's here 42 *deg.* 00 *min.*

The *departure* from the *Meridian* B D, is 68 leagues.

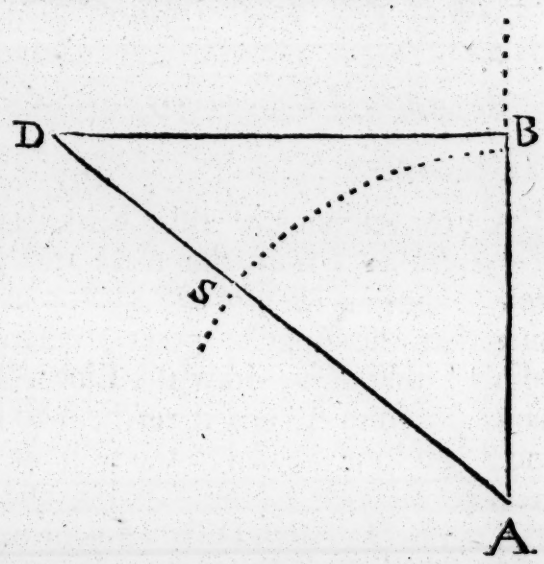
The *Courſe* is South 59 *deg.* 35 *min.* Eaſterly, or South Eaſt by Eaſt 3 *deg.* 20 *min.* Eaſterly.

Difference of Latitude *and* departure *from the Meridian given, to find the* diſtance run *and* Courſe.

Queſt. 4.

Admit I ſet from a Head Land, *and ſail upon ſome point between the North and the Weſt, till I alter my Latitude* 1 deg. 30 min. *or* 30 *leagues, and depart from my Meridian* 39 *leagues; I demand my* Courſe made good, *and* diſtance run?

FOr the anſwering this Queſtion, I draw my North and South Line (as before) and upon it I ſuppoſe the Head Land to be, as at A; then I take off the difference of Latitude from the Scale, and from A, ſet it off to the Northwards (becauſe I ſail to the Northwards) and it reacheth to B: from B then I raiſe a Perpendicular, and ſet off my Meridian diſtance upon it 39 *leagues*, which reacheth from B to D, and conclude the Ship is at D, becauſe therein the Parallel of Latitude is 39 leagues from the Meridian, according to the Queſtion. Draw the ſide D A, which is the diſtance run, and take it off, and meaſure (as before hath been ſhewed) alſo, take off the Courſe, by deſcribing the Arch of 60 *deg.* B S, and taking it off and applying it to your Line of Points (as hath been ſhewed) or to the Line of Chords, if you deſire it in degrees.



The *Courſe made good*, is North 52 *deg.* Weſterly.

The *diſtance run* is D A, 49 leagues $\frac{1}{2}$.

The like is to be underſtood of any other Queſtion of this kind, but this ſhall ſuffice.

CHAP. IX.

How to work any Travers *by the Plain Scale.*

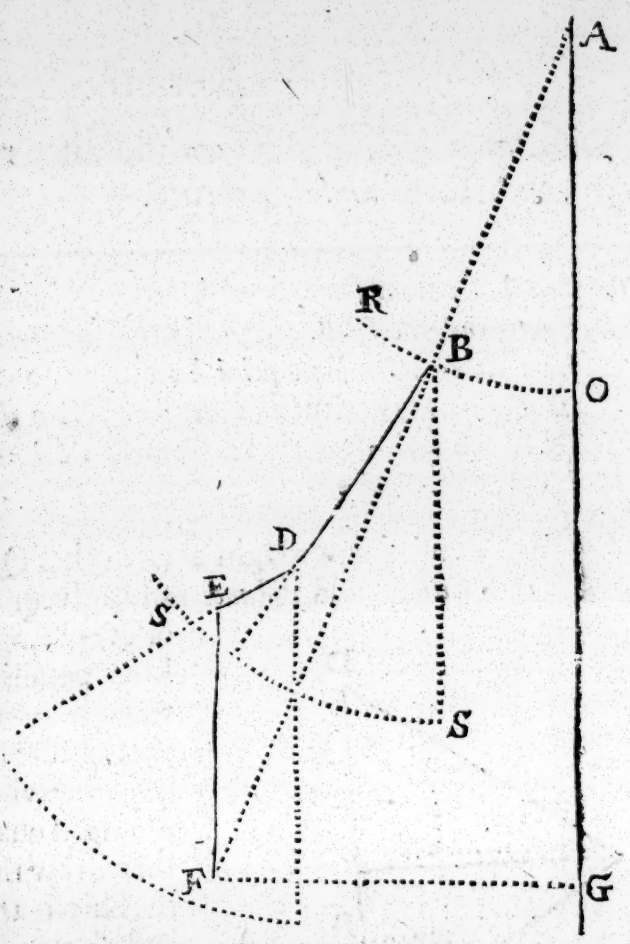
WE come next to treat of any *Traverſes*, that is, when there be many Courſes and diſtances, how to ſet them off, and to reduce the whole Work to one Triangle, and from it to be reſolved.

The Firſt Travers.

Admit I ſet from a certain Port, and ſail South South Weſt 60 leagues; from thence South Weſt by South 40 leagues; from thence South Weſt by Weſt 17 leagues; from thence South 40 leagues. Now if the Port I ſet from was in North Latitude 32 deg. 20 min. *I demand what* Latitude *I am in, my* departure *from my firſt Meridian; as alſo my* Courſe *upon a ſtreight Line, and my* diſtance *from the place I ſet?*

FOr the reſolving of this, Firſt, draw a North and South Line, as A G, as (from the place that you propoſe to your ſelf to ſet from) take an Arch of 60 *deg.* 00 *min.* from your Scale, (and making that the Angular point) deſcribe it, as O R, and ſet off two points; that done, draw the Line A B, and upon it ſet off your diſtance run from A, and it reacheth to B; from B draw another North and South Line parallel to the firſt, as B S, and by an Arch of 60 degrees ſet off your ſecond Courſe, and your diſtance upon it, and it reacheth to D; from D ſet off your next Courſe and diſtance, and it reacheth from D to E; then from E, upon a South Line, ſet off your laſt

laſt diſtance run, and it reacheth from E to F. Now becauſe there is no more Courſes and diſtances, I conclude the Ship is at F; and therefore, if you draw a Line from F to the Port you ſet from at A, (as A F) it's apparently the diſtance you are from the Port you ſet from; (after all theſe Courſes and diſtances ſailed) and by the firſt Arch of 60 degrees, you may take off the Courſe made good ſince you ſet out, which is B O; and if from the ſame place, at the end of your ſailing, you let fall the Perpendicular F G, the length of it is the whole *Meridian diſtance* or *departure* from your firſt *Meridian*; and A G is your whole *difference of Latitude*: which ſubſtracted from the Latitude you ſailed from, leaves the Latitude you are now in (becauſe you are in North Latitude, and have ſailed to the Southwards.) They are, as followeth:



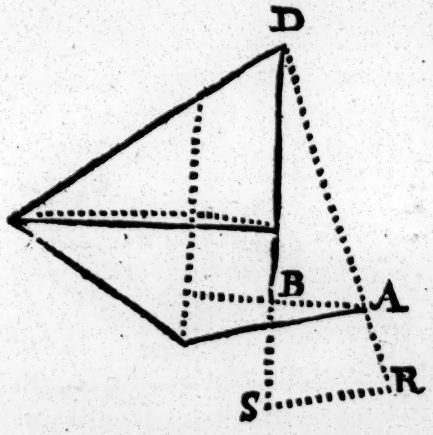
The *diſtance* run A F, is 150 leagues.
The *Courſe made good* B O, is *South South Weſt* 1 deg. *Weſterly.*
The *difference of Latitude* G A, is 138 leagues.
That ſubſtracted from 32 *deg.* 20′ after it is converted into miles, is } 25 *deg.* 26′
The *departure* from the firſt Meridian is F G 59 leagues *Weſt.*
The like is to be underſtood of any other Travers of this nature.

Travers the Second.

Difference *of* Latitude, *and* diſtance run, *being given, to find the* Courſe *and* departure.

Admit I ſet from ſome Head Land, *and ſail upon ſome point between the South and the Weſt,* 56 *leagues, till I alter my* Latitude 1 deg. 30′; *from thence upon ſome point between the South and the Eaſt* 37 *leagues, till I alter my* Latitude 1 *degree*; *from thence upon ſome point between the North and the Eaſt* 30 *leagues, till I alter my* Latitude 10 *leagues*; *I demand, as before.*

THis Travers is wrought as any other Queſtion, where the *difference of Latitude* and *diſtance run* is given, onely from the concluſion of every Angle draw a North and South Line parallel to the firſt, and do as though it were another Queſtion of that nature, till you have ſet them all off, obſerving to ſet your Courſes in the right quarters of the Compaſs; and then draw the Line A D from the place the Ship is at, to the place you ſet from, and ſo you have A D for your whole diſtance run ſince you came out: A B for your whole Meridian diſtance; S R is the Courſe made good from the place I ſet out: All which, are as followeth.



A D the *diſtance* is	58 leagues neareſt.
A B the *Meridian diſtance*,	11 leagues.
S R the *Courſe* made good, is	*North* 16 leagues *Eaſterly.*
B D the *difference of Latitude*, is	38 leagues *Weſt* 2 *deg.* 54′.

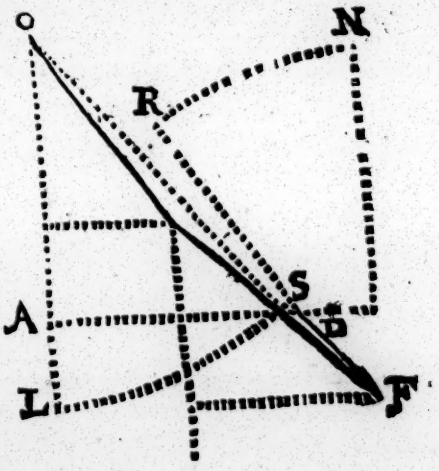
Travers

Travers the Third.

Courſe *and* difference of Latitude *given, to find the* diſtance *run, and* departure.

Admit a Ship ſets from a certain Port, and ſails South Eaſt by South, till he alters his Latitude 1 deg. 30′; *from thence South Eaſt, till ſhe alters her Latitude* 1 deg. 30′; *then North Weſt by North, till ſhe alters her Latitude* 15 *leagues, and then obſerves, and is in the Latitude of* 40 deg. 00′ *North; I demand the* Latitude *of the place ſhe ſet from, and her* departure *from her* firſt Meridian.

THis Travers is wrought as any other Queſtion, where the Courſe and difference of Latitude is given, onely from the end of every Courſe and difference of Latitude laid down, draw a North and South Line parallel to the firſt, and do as though it were another Queſtion of that kind, till you come to the end of the *Travers*, and then let fall the Perpendicular A D, and draw the Line D O, and reſolve the whole Travers, as before in the laſt *Travers*: onely obſerve in this, and all other *Traverſes*, that you ſet your Angles in the right quarter of the Compaſs; as here the third Courſe is North Weſt by North, and therefore I ſet it off from the North and South Line F N towards R, which is from the North to the Weſtwards 3 points, always making (as I ſhewed before) that part of your Book that is right from you, the North part; and ſo theſe Courſes in the Travers repreſent the Lines that they be drawn for. The Anſwer of this Travers is as followeth.



The *diſtance run* upon a ſtreight Line, is D O — 175 miles.
The *Courſe made good* is L S, the meaſure of the Angle A O D, } No. 43 *deg. Weſterly*
The *departure* from the firſt *Meridian* is D A — 120 miles.
The *difference of Latitude* from the place I ſet, is A O — 135 miles.
And by conſequence the Latitude I ſet from is — 42 *deg.* 15′
becauſe I am ſo much more Southerly than that Latitude that I ſet from, by the difference of Latitude. And thus is any Travers of this nature reſolved.

Travers

Travers the Fourth, *Of South Latitude.*

Admit I ſet from South Latitude 50 deg. 00′, *and ſail South by Weſt* 42 *leagues, from thence South Weſt* 40 *leagues, from thence South South Eaſt* 28 *leagues; I demand what* Latitude *I am in, and my* Courſe *ſailed, my* diſtance *from the place I ſet, and* Meridian diſtance.

THis Travers is projected and reſolved as the firſt Travers was, and therefore it is but ſuperfluous to ſay any thing of it; but in the concluſion I find I have differed my Latitude 94 leagues $\frac{1}{2}$, and it is demanded of me what Latitude I am in. Now becauſe I am in a Southern Latitude, and my difference of Latitude is Southerly, therefore my Latitude is increaſed ſo much as my difference of Latitude is; ſo that I muſt adde that to the Latitude I departed from, and it makes the Latitude I am now in 54 *deg.* 44′.

And the reaſon is plain: For if you are in a Northern Latitude, and ſail to the Northwards, your Latitude increaſeth; ſo likewiſe, if you be in a Southern Latitude, and ſail Southerly, your Latitude muſt increaſe, for the ſame reaſon.

Thus much for *Traverſes* protracted; which I look upon to be very tedious at Sea to do it this way; for ſometimes by contrary Winds a Ship may make five or ſix Courſes in twenty four hours, and to protract them thus, would be very tedious: and therefore my Father made a Table of Courſe and Diſtance, that gives the difference of Latitude and departure very readily; and becauſe it is (by ſome body) almoſt ſpoiled, for it is printed with Complements below and above, and Latitude ſet in one Colume, and Departure in the other, which makes nonſence of that Table, which (as it was meant and printed from the Original Copy) was the plaineſt and eaſieſt of Tables; and that I'll make appear by ſeveral Examples. The Table (according to my Fathers deſire) is inſerted in this Book, as he firſt did them. But to proceed to the Uſe of the Tables.

CHAP.

CHAP. X.

The Use of the following large Table of Longitude *and* Departure, *in working of* Traverſes.

Example the Firſt.

Admit I had a Travers as this is that followeth.

	South.	*Eaſt.*	
1. *South by Eaſt* 10 *miles*	9. 8	1. 9	or 11 *deg.*
2. *Then South Eaſt by South* 20 *miles*	16. 6	11. 2	or 34 *deg.*
3. *Then South South Eaſt* 24 *miles*	22. 2	09. 0	
4. *Then South Eaſt* 15 *miles*	10. 6	10. 6	
	South 59. 2	*Eaſt* 32. 7	

FOr the working this *Travers*, I look in the Tables for the firſt Courſe, and becauſe it is one point from the South, I take the Southing under 11 *deg.* 00′ (which is the neareſt to one point) and againſt the diſtance run upon that point, which is 10 miles, I find 9 miles 8 tenths of a mile ; and in my next Colume I find 1 mile 9 tenths for my Eaſting, (which is under 79 *deg.* my Courſe from the Eaſt) ſet it down as in the Example before ; then I look for my next Courſe, and it's South Eaſt by South (which is three points from the South to the Eaſtward, or neareſt 34 *deg.*) under 34 *deg.* and againſt 20 miles (the diſtance run) I find 16 miles 6 tenths for my Southing, and 11 miles 2 tenths for my Eaſting: And in like manner do by the reſt. Now having taken them all, I adde up my Southing, and it makes 59 miles 2 tenths ; and my Eaſting added up, makes 32 miles 7 tenths.

If you would know your Courſe made good, and diſtance run upon that Courſe, then look for your Eaſting and Southing in the Tables, where they will anſwer in one line, and againſt that in the ſame line is the diſtance run, and over your Southing is the Courſe made good from the Meridian of South Eaſterly. In this Caſe, the diſtance run is 70 miles, my Courſe South 33 *deg.* Eaſterly.

Example

Example the Second.

Admit this 24 hours I have ſailed as followeth.

	South.	*Eaſt.*	*North*	*Weſt.*
South South Eaſt 15 miles	13. 9	05. 6	00. 0	00. 0
South South Weſt 18 miles	16. 7	00. 0	00. 0	06. 7
South Weſt by South 20 miles	16. 6	00. 0	00. 0	11. 2
Eaſt by North 18 miles	00. 0	17. 7	03. 4	00. 0
	47. 2	23. 3	03. 4	17. 9
	3. 4	17. 9		
	South 43. 8	*Eaſt* 05. 4		

FOr the working of this *Travers*, take the Courſes and diſtances out of the Tables (as before) and againſt them is the *difference of Latitude and Departure*, as was ſhewed, and as here appears; but obſerve to put your Northing and Southing, Eaſting and Weſting, diſtinct, as you ſee it done here: and when you have done. Adde them up ſeverally; and then ſubſtract the leſſer number, whether of your Southing or Northing, from the greater, and the remainder is the difference of Latitude, either South or North; as in this caſe the greateſt was Southerly, now the Northing being ſubſtracted, the remainder is 43 miles 8 tenths Southing; in that reckoning alſo, the greateſt Meridian diſtance was Eaſt, I have taken the Weſting from it, and the remainder is 5 miles 4 tenths clear Eaſting: And thus you may find your Eaſting and Weſting, Northing and Southing, in any Travers or ſingle Courſe, which is ſufficient for any man to keep a reckoning at Sea by, & indeed the only way that I know, unleſs there were ſome way to find the Longitude by obſervation, as well as the Latitude; (which thing I purpoſe to ſhew as ſoon as I can come to it.) Now I would wiſh every man to keep his reackoning by Latitude and Longitude, for ſo he is ready at all times to give his account either to himſelf, or any body elſe, as I'll prove by the Examples of Reckonings following after the Table, which I thought good here to inſert.

Note, that this Table goeth but to 100 miles diſtance run, but if your diſtance be more, take it at twice, thus:

Admit the Courſe were North 31 *deg.* Eaſterly 142 miles, I ſet it thus, and adde them together.

North

North Eaſterly 31 *deg.*	100	85. 7	51. 5
North Eaſterly 31 *deg.*	042	36. 0	21. 6
		North 21. 7	*Eaſt* 73. 1

Mr. *Colſome* hath taken the liberty to tranſcribe the following Table, and placed it in his new Kalendar, but with ſome Alteration and needleſs Addition, and then is pleaſed to call it, *A Table larger and better contrived than any of this nature yet extant.* Now for the inlarging of it, he hath calculated a Colume for every quarter of a Point of the Compaſs, which is a very uſeleſs thing; no point or quarter falling above 30 minutes of a degree of the Compaſs (which is not one two and twentieth part of a point of the Compaſs) from what's done by my Father many years ſince; and for 24 points of the Compaſs but 15 minutes of a degree (which is neither of them to be minded:) But I think he never uſed the Sea, and ſo may believe that a man can ſail to a hairs breadth at leaſt. But I would fain know if the quarters of points muſt be done ſo exactly, why every degree of the Compaſs ſhould not as well be divided into ſuch nicities? Now for this and his writing *Latitude* in one Colume, and *Departure* in another, againſt the Diſtance, (very contrary to my Fathers meaning, and moſt mens underſtanding) and Compliments below and above, (which is very odde) he intimates himſelf to be the Author of the whole Table; which is implied in theſe words of his: (*page* 132 of his Book) *This is a Table larger and better contrived than any of this nature yet extant.* I wonder at his Confidence, to venture to print ſuch a Table for his own, which was publiſhed by my Father many years before he was born, and is onely ſpoiled by Mr. *Colſome* in his aſſumed Book; and by ſomebody of late, who hath printed it after the ſame nonſencical manner (the quarters of points excepted) in my Fathers *Sea-mens Practice.*

The Tables here following are as they were firſt deſigned to be printed by the Author; the quarters and half points were done by Mr. *Philips*; and ſince that, by Mr. *John Sellers*: ſo that they are no way inlarged by any invention of Mr. *Colſome*, though he is pleaſed to ſay ſo. But I wonder at it, ſince I ſaw his Arrogant Epiſtle to poor Captain *Sturmy*'s *Magazeen*; but extreamly at the Stationers, for ſuffering that Epiſtle to be printed, notwithſtanding he received a conſiderable ſum for his pains to correct and purge that Book of the impertinencies and abſurdities (committed by the Author, and omitted by Mr. *H. P.* in the firſt impreſſion.) I ſhould be thankful, if any man would

shew me what real improvements Mr. *C.* or any man else hath made to the latter Edition, more than an Arrogant Epistle full of ungrateful Reflections on the Author; and after eighteen months consideration or reviewing the Copy, which some are apt to believe might been done in less than eighteen days, to much better purpose; though he intimates that he had added the *Doctrine of Spherical Triangles*, (if his own) it's invisible to all men but himself: for all the twenty eight Cases, I find them taken out of Mr. *Gillibrand*'s *Trigonometry*, wherein he gives us but two Examples. What's added in *Astronomy*, I as yet know not; for having none of the Books by me of that Edition, I cannot examine nor compare it with the last: yet for the *Dyalling*, the little that appears of it, seems to be Mr. *Foster*'s, published many years before. The first Book of *Geometry*, and that little he hath added of *Surveying* in the fifth Book, is wholly taken out of Mr. *Leybourn*'s *Compleat Surveyor*. The *Gunnery* and *Fire-works*, from Mr. *Babington* and Mr. *Nye*'s Books on that subject. And I doubt not, had I time to trace our Corrector throughout, he might have spared his Reflection on Mr. *Sturmy*, and bestowed them upon his Pay-masters. How mean, and unlike an Artist, such practices are, the Author being then dead, I leave to any man of sence to judge. What he hath said concerning the managing of a Ship in all Weathers, is Captain *Saltenstal*'s, printed above forty years since, in his *Navigator*.

Before I come to the large Tables that are calculated to every degree of the Compass, I have thought good here to insert a small *Travers-Table*, with its Use, which is very exact and speedy; and I call it, *A Table of Northing and Southing*, (never in print before, as I know of.) But further Uses of the large Tables, shall follow after them.

CHAP. XI.

A Table of Northing *and* Southing, Easting *and* Westing, *to ever* Point, half Point, *and* quarter Point *of the* Compass: *With its Use.*

THis Table is very easie, and performs the work of the larger to one quarter of a Point of the Compass. The manner to work by, it is as followeth.

The

The Table of Northing *and* Southing, *&c.*

O	East.	West.	Difference & Departure		West.	East.	VIII
Points	Quarters of Points 1		049	998	3		Points
			098	995	2	Quarters of Points	
			140	989	1		
I	N by E | S by E	N by W | S by W	195	980	W by S | W by N	E by N | E by S	VII
	Quarters of Points 1		243	970	3		
			290	957	2	Quarters of Points	
			336	941	1		
II	N N E | S S E	N N W | S S W	383	923	W S W | W N W	E N E | E S E	VI
	Quarters of Points 1		427	903	3		
			471	881	2	Quarters of Points	
			514	858	1		
III	N E by N | S E by S	N W by N | S W by S	556	831	S W by W | N W by W	N E by E | S E by E	V
	Quarters of Points 1		596	803	3		
			634	773	2	Quarters of Points	
			671	741	1		
IV	N E | S E	N W | S W	707	707	S W | N W	N E | S E	IV

Whatſoever your *diſtance run* is (whether you take it in *miles* or *leagues*) multiply it by the numbers which ſtand againſt the Point of the Compaſs you ſail upon in the Tables, caſting away as many figures of the product to the right hand, as you took out of the Table, namely three, and the remainder is (one) the *difference of Latitude*; the other is the *Meridian diſtance*; and the figures cut off a thouſand parts of a mile or league in each. But to know which is *difference of Latitude* and which *departure*, conſider whether your Courſe be nearer the Meridian of *North* and *South*, or the *Parallel* of *Eaſt* and *Weſt*; if nearer to the *North* or *South*, your *difference of Latitude* is the greateſt number; but if neareſt to the *Eaſt* or *Weſt*, your *Meridian diſtance* is the greateſt, (and this your own reaſon muſt give you.) Queſt.

Quest. 1.

Admit I set from a Head Land, and sail South West by West 70 *miles, I demand my* difference of Latitude, *and* departure *from my* Meridian.

I Look for 5 points, or three, in the Table, and find against it in the two middle Columes 831 and 556 I multiply these two numbers by 70,

	70	70
The Distance run, and they produce	58,170	38,920

I conclude then that my departure from the Meridian is 58 $\frac{170}{1000}$ miles; that is, 58 miles, and 17 hundred parts of a mile. And my *difference of Latitude* is 38 $\frac{920}{1000}$ miles, or 38 miles, and 92 hundred parts of a mile, which is near 39 miles. And the reason why my *departure* is the *greatest*, is, because my *Course* is more *Westerly* than *Southerly*. The like is to be understood of any other.

Quest. 2.

Admit I sail North, three quarters of a point Easterly 81 *miles, I demand my* difference of Latitude *and* departure *from the* Meridian.

AGainst three quarters of one Point of the Compass, I look and find these numbers 140 and 989

81	81
140	989
1120	7912
11,340	80,109

I consider here, my *Course* is nearer to the *North* than to the *East*; therefore my *difference of Latitude* is 80 $\frac{109}{1000}$ or $\frac{1}{10}$ miles; that is, 80 miles, and one tenth part of a mile. And my *Meridian distance* is 11 $\frac{340}{1000}$ or $\frac{3}{10}$ miles; or 11 miles, and 34 hundred parts of a mile.

And let this suffice for the Use of this little table. But before I come to shew the Uses of the following large Tables, I will first shew you how the same Tables are made; which take briefly as followeth.

CHAP.

CHAP. XII.

The Conſtruction of the Table of difference of Latitude *and* Departure.

SUppoſe that I ſet ſail from a Port upon a Courſe 58 degrees from the Meridian, and ſail thereon 85 miles; I would know then how much I have *altered my Latitude*, and how much I have *departed* from the *Meridian* I ſet from.

The Proportion is,

1. *For the Departure.*

As the Radius, or Sine of 90 degrees .	10. 00000
Is to the Logarithm of the diſtance run, 85 miles	1. 92942
So is the Sine of the Courſe from the Meridian 58 deg.	9. 92842
To the Logarithm of 72. 1 miles the *departure*	11. 85784

2. *For the differences of Latitude.*

As the Radius, 90 degrees	10. 00000
Is to the Logarithm of the diſtance run 85 miles	1. 92942
So is the Sine Complement of the Courſe from the Meridian 32 degres	9. 72421
To the Logarithm of 45 miles, the *difference of Latitude*	11. 65363

And if you look into the following Table, under 58 degrees, and againſt 35 miles, you ſhall find this number 45. 0 miles for the *difference of Latitude.*

And (in the ſame page and line) under 32 degrees, and againſt 30, you ſhall find this number 72. 1 miles for your *departure.*

And in this manner may you find any other *numbers* in the *Table* following.

And

And becauſe the *Titles* at the head of the *Table* are by *degrees* from 1 to 45, and returned back again by their Complements to 90 deg. I have here inſerted this Table; whereby, (if your *Courſe* be given you in *Points*, or *Points* and *quarters* of *Points* of the Compaſs) you may readily know what *degree* in the head of the *Table* you muſt take inſtead thereof.

Example.

Suppoſe your Courſe given were S by E *a quarter of a Point Eaſterly*; Look in this little Table for this Point, and quarter, and againſt it you ſhall find 14 *deg.* 4 *min.* ſo that inſtead of S by E a quarter of a Point Eaſterly, you muſt make uſe of 14 *deg.* in the Table, which is the neareſt number of degrees thereunto: Alſo inſtead of N E by E half a Point Eaſterly, you muſt take 62 degrees, it being the neareſt in the Table to 61 *deg.* 52 *min.* which ſtands againſt N E by E half a Point Eaſt, *&c.*

A Table ſhewing the number of Degrees and Minutes, that each Point and quarter of a Point of the Compaſs makes with the Meridian.

Points	North.	South.	deg.	min.	South.	North.	Points
			2	49			
			5	38			
			8	26			
1	N by E	S by E	11	15	S by W	N by W	1
			14	4			
			16	53			
			19	41			
2	N N E	S S E	22	90	S S W	N N W	2
			25	19			
			28	8			
			30	36			
3	N E by N	S E by S	33	45	S W by S	N W by N	3
			36	34			
			39	23			
			42	11			
4	N E	S E	45	0	S W	N W	4
			47	49			
			50	37			
			53	26			
5	N E by E	S E by E	56	15	S W by W	N W by W	5
			59	4			
			61	52			
			64	41			
6	E N E	E S E	67	30	W S W	W N W	6
			70	19			
			73	7			
			75	56			
7	E by N	E by S	78	45	W by S	W by N	7
			81	34			
			84	22			
			87	11			
8	East.	East.	90	0	West.	West.	8

A

TABLE

Shewing the Difference of

Latitude & Departure

FROM THE

MERIDIAN.

Distances.	1 degr. Latitude and Departure.	89 degr. Latitude and Departure.
1	1.0	0
2	2.0	0
3	3.0	0
4	4.0	1
5	5.0	1
6	6.0	1
7	7.0	1
8	8.0	1
9	9.0	2
10	10.0	2
11	11.0	2
12	12.0	2
13	13.0	2
14	14.0	2
15	15.0	3
16	16.0	3
17	17.0	3
18	18.0	3
19	19.0	3
20	20.0	4
21	21.0	4
22	22.0	4
23	23.0	4
24	24.0	4
25	25.0	4
26	26.0	5
27	27.0	5
28	28.0	5
29	29.0	5
30	30.0	5
31	31.0	5
32	32.0	6
33	33.0	6
34	34.0	6
35	35.0	6
36	36.0	7
37	37.0	7
38	38.0	7
39	39.0	7
40	40.0	7
41	41.0	7
42	42.0	7
43	43.0	8
44	44.0	8
45	45.0	8
46	46.0	8
47	47.0	8
48	48.0	9
49	49.0	9
50	50.0	9
51	51.0	9
52	52.0	9
53	53.0	9
54	54.0	1.0
55	55.0	1.0
56	56.0	1.0
57	57.0	1.0
58	58.0	1.0
59	59.0	1.0
60	60.0	1.1
61	61.0	1.1
62	62.0	1.1
63	63.0	1.1
64	64.0	1.1
65	65.0	1.2
66	66.0	1.2
67	67.0	1.2
68	68.0	1.2
69	69.0	1.2
70	70.0	1.2
71	71.0	1.3
72	72.0	1.3
73	73.0	1.3
74	74.0	1.3
75	75.0	1.3
76	76.0	1.3
77	77.0	1.4
78	78.0	1.4
79	79.0	1.4
80	80.0	1.4
81	81.0	1.4
82	82.0	1.4
83	83.0	1.5
84	84.0	1.5
85	85.0	1.5
86	86.0	1.5
87	87.0	1.5
88	88.0	1.5
89	89.0	1.6
90	90.0	1.6
91	91.0	1.6
92	92.0	1.6
93	93.0	1.6
94	94.0	1.7
95	95.0	1.7
96	96.0	1.7
97	97.0	1.7
98	98.0	1.7
99	99.0	1.7
100	100.0	1.8
200	200.0	3.5
300	300.0	5.3

Distances.	2 degr.	88 degr.
	Latitude and Departure.	
1	1.0	0
2	2.0	1
3	3.0	1
4	4.0	1
5	5.0	2
6	6.0	2
7	7.0	2
8	8.0	3
9	9.0	3
10	10.0	3
11	11.0	4
12	12.0	4
13	13.0	4
14	14.0	5
15	15.0	5
16	16.0	6
17	17.0	6
18	18.0	6
19	19.0	7
20	20.0	7
21	21.0	7
22	22.0	8
23	23.0	8
24	24.0	8
25	25.0	9
26	26.0	9
27	27.0	9
28	28.0	1.0
29	29.0	1.0
30	30.0	1.0
31	31.0	1.1
32	32.0	1.1
33	33.0	1.1
34	34.0	1.2

Distances.	2 degr.	88 degr.
	Latitude and Departure.	
35	35.0	1.2
36	36.0	1.3
37	37.0	1.3
38	38.0	1.3
39	39.0	1.4
40	40.0	1.4
41	41.0	1.4
42	42.0	1.5
43	43.0	1.5
44	44.0	1.5
45	45.0	1.6
46	46.0	1.6
47	47.0	1.6
48	48.0	1.7
49	49.0	1.7
50	50.0	1.7
51	51.0	1.8
52	52.0	1.8
53	53.0	1.8
54	54.0	1.9
55	55.0	1.9
56	56.0	1.9
57	57.0	2.0
58	58.0	2.0
59	59.0	2.0
60	60.0	2.1
61	61.0	2.1
62	62.0	2.2
63	63.0	2.2
64	64.0	2.2
65	65.0	2.3
66	66.0	2.3
67	67.0	2.3
68	68.0	2.4

Distances.	2 degr.	88 de.
	Latitude and Departure.	
69	69.0	2.4
70	70.0	2.4
71	71.0	2.5
72	72.0	2.5
73	73.0	2.5
74	74.0	2.6
75	75.0	2.6
76	76.0	2.6
77	77.0	2.7
78	78.0	2.7
79	79.0	2.8
80	80.0	2.8
81	80.9	2.8
82	81.9	2.9
83	82.9	2.9
84	83.9	2.9
85	84.9	3.0
86	85.9	3.0
87	86.9	3.0
88	87.9	3.1
89	88.9	3.1
90	89.9	3.1
91	90.9	3.2
92	91.9	3.2
93	92.9	3.2
94	93.9	3.3
95	94.9	3.3
96	95.9	3.4
97	96.9	3.4
98	97.9	3.4
99	98.9	3.5
100	99.9	3.5
200	199.8	7.0
300	299.7	10.5

Distances.	3 degr.	87 degr.
	Latitude and Departure.	
1	1.0	1
2	2.0	1
3	3.0	1
4	4.0	2
5	5.0	2
6	6.0	3
7	7.0	4
8	8.0	4
9	9.0	5
10	10.0	5
11	11.0	6
12	12.0	6
13	13.0	7
14	14.0	7
15	15.0	8
16	16.0	8
17	17.0	9
18	18.0	9
19	19.0	1.0
20	20.0	1.0
21	21.0	1.1
22	22.0	1.1
23	23.0	1.2
24	24.0	1.2
25	25.0	1.3
26	26.0	1.3
27	27.0	1.4
28	28.0	1.5
29	29.0	1.5
30	30.0	1.6
31	31.0	1.6
32	32.0	1.7
33	33.0	1.7
34	34.0	1.8

Distances.	3 degr.	87 degr.
	Latitude and Departure.	
35	35.0	1.8
36	36.0	1.9
37	37.0	1.9
38	38.0	2.0
39	39.0	2.0
40	40.0	2.1
41	41.0	2.1
42	42.0	2.2
43	43.0	2.2
44	44.0	2.3
45	45.0	2.3
46	46.0	2.4
47	47.0	2.4
48	48.0	2.5
49	49.0	2.6
50	50.0	2.6
51	50.9	2.7
52	51.9	2.7
53	52.9	2.8
54	53.9	2.8
55	54.9	2.9
56	55.9	2.9
57	56.9	3.0
58	57.9	3.0
59	58.9	3.1
60	59.9	3.1
61	60.9	3.2
62	61.9	3.2
63	62.9	3.3
64	63.9	3.3
65	64.9	3.4
66	65.9	3.5
67	66.9	3.5
68	67.9	3.6

Distances.	3 degr.	87 de
	Latitude and Departure.	
69	68.9	3.6
70	69.9	3.7
71	70.9	3.7
72	71.9	3.8
73	72.9	3.8
74	73.9	3.9
75	74.9	3.9
76	75.9	4.0
77	76.9	4.0
78	77.9	4.1
79	78.9	4.1
80	79.9	4.2
81	80.9	4.2
82	81.9	4.3
83	82.9	4.3
84	83.9	4.4
85	84.9	4.4
86	85.9	4.5
87	86.9	4.5
88	87.9	4.6
89	88.9	4.6
90	89.9	4.7
91	90.9	4.8
92	91.9	4.8
93	92.9	4.9
94	93.9	4.9
95	94.9	5.0
96	95.9	5.0
97	96.9	5.1
98	97.9	5.1
99	98.9	5.2
100	99.9	5.2
200	199.7	10.5
300	299.6	15.7

Distances.	4 degr.	86 degr.
	Latitude and Departure.	
1	1.0	1
2	2.0	1
3	3.0	2
4	4.0	3
5	5.0	3
6	6.0	4
7	7.0	5
8	8.0	6
9	9.0	6
10	10.0	7
11	11.0	8
12	12.0	8
13	13.0	9
14	14.0	1.0
15	15.0	1.0
16	16.0	1.1
17	17.0	1.2
18	18.0	1.3
19	19.0	1.3
20	20.0	1.4
21	20.9	1.5
22	21.9	1.5
23	22.9	1.6
24	23.9	1.7
25	24.9	1.7
26	25.9	1.8
27	26.9	1.9
28	27.9	2.0
29	28.9	2.0
30	29.9	2.1
31	30.9	2.2
32	31.9	2.2
33	32.9	2.3
34	33.9	2.4
35	34.9	2.5
36	35.9	2.5
37	36.9	2.6
38	37.9	2.7
39	38.9	2.7
40	39.9	2.8
41	40.9	2.9
42	41.9	2.9
43	42.9	3.0
44	43.9	3.1
45	44.9	3.1
46	45.9	3.2
47	46.9	3.3
48	47.9	3.4
49	48.9	3.4
50	49.9	3.5
51	50.9	3.6
52	51.9	3.6
53	52.9	3.7
54	53.9	3.8
55	54.9	3.8
56	55.9	3.9
57	56.9	4.0
58	57.9	4.0
59	58.9	4.1
60	59.9	4.2
61	60.9	4.3
62	61.9	4.3
63	62.9	4.4
64	63.9	4.5
65	64.8	4.5
66	65.8	4.6
67	66.8	4.7
68	67.8	4.8
69	68.8	4.8
70	69.8	4.9
71	70.8	4.9
72	71.8	5.0
73	72.8	5.1
74	73.8	5.2
75	74.8	5.2
76	75.8	5.3
77	76.8	5.4
78	77.8	5.5
79	78.8	5.5
80	79.8	5.6
81	80.8	5.7
82	81.8	5.7
83	82.8	5.8
84	83.8	5.9
85	84.8	5.9
86	85.8	6.0
87	86.8	6.1
88	87.8	6.1
89	88.8	6.3
90	89.8	6.3
91	90.8	6.4
92	91.8	6.5
93	92.8	6.5
94	93.8	6.6
95	94.8	6.6
96	95.8	6.7
97	96.8	6.8
98	97.8	6.8
99	98.8	6.9
100	99.8	7.0
200	199.5	14.0
300	299.3	20.9

Distances.	5 *degr.*	85 *degr.*
	Latitude and Departure.	
1	1.0	1
2	2.0	2
3	3.0	3
4	4.0	3
5	5.0	4
6	6.0	5
7	7.0	6
8	8.0	7
9	9.0	8
10	10.0	9
11	11.0	1.0
12	12.0	1.0
13	13.0	1.1
14	14.0	1.2
15	15.0	1.3
16	15.9	1.4
17	16.9	1.5
18	17.9	1.6
19	18.9	1.7
20	19.9	1.7
21	20.9	1.8
22	21.9	1.9
23	22.9	2.0
24	23.9	2.1
25	24.9	2.2
26	25.9	2.3
27	26.9	2.4
28	27.9	2.4
29	28.9	2.5
30	29.9	2.6
31	30.9	2.7
32	31.9	2.8
33	32.9	2.9
34	33.9	3.0

Distances.	5 *degr.*	85 *degr.*
	Latitude and Departure.	
35	34.9	3.0
36	35.9	3.1
37	36.9	3.2
38	37.9	3.3
39	38.8	3.4
40	39.8	3.5
41	40.8	3.6
42	41.8	3.7
43	42.8	3.7
44	43.8	3.8
45	44.8	3.9
46	45.8	4.0
47	46.8	4.1
48	47.8	4.2
49	48.8	4.3
50	49.8	4.4
51	50.8	4.5
52	51.8	4.5
53	52.8	4.6
54	53.8	4.7
55	54.8	4.8
56	55.8	4.9
57	56.8	5.0
58	57.8	5.1
59	58.8	5.2
60	59.8	5.2
61	60.8	5.3
62	61.8	5.4
63	62.8	5.5
64	63.8	5.6
65	64.8	5.7
66	65.8	5.8
67	66.8	5.8
68	67.8	5.9

Distances.	5 *degr.*	85 *dc.*
	Latitude and Departure.	
69	68.7	6.0
70	69.7	6.1
71	70.7	6.2
72	71.7	6.3
73	72.7	6.4
74	73.7	6.5
75	74.7	6.5
76	75.7	6.6
77	76.7	6.7
78	77.7	6.8
79	78.7	6.9
80	79.7	7.0
81	80.7	7.1
82	81.7	7.1
83	82.7	7.2
84	83.7	7.3
85	84.7	7.4
86	85.7	7.5
87	86.7	7.6
88	87.7	7.7
89	88.7	7.8
90	89.7	7.8
91	90.7	7.9
92	91.6	8.0
93	92.6	8.1
94	93.6	8.2
95	94.6	8.3
96	95.6	8.4
97	96.6	8.4
98	97.6	8.5
99	98.6	8.6
100	99.6	8.7
200	199.2	17.4
300	298.9	26.2

Distances.	5 degr.	84 degr.
	Latitude and Departure.	
1	1.0	1
2	2.0	2
3	3.0	3
4	4.0	4
5	5.0	5
6	6.0	6
7	7.0	7
8	8.0	8
9	8.9	9
10	9.9	1.0
11	10.9	1.1
12	11.9	1.2
13	12.9	1.4
14	13.9	1.5
15	14.9	1.6
16	15.9	1.7
17	16.9	1.8
18	17.9	1.9
19	18.9	2.0
20	19.9	2.1
21	20.9	2.2
22	21.9	2.3
23	22.9	2.4
24	23.9	2.5
25	24.9	2.6
26	25.9	2.7
27	26.8	2.8
28	27.8	2.9
29	28.8	3.0
30	29.8	3.1
31	30.8	3.2
32	31.8	3.3
33	32.8	3.4
34	33.8	3.5

Distances.	6 degr.	84 degr.
	Latitude and Departure.	
35	34.8	3.6
36	35.8	3.8
37	36.8	3.9
38	37.8	4.0
39	38.8	4.1
40	39.8	4.2
41	40.8	4.3
42	41.8	4.4
43	42.8	4.5
44	43.8	4.6
45	44.7	4.7
46	45.7	4.8
47	46.7	4.9
48	47.7	5.0
49	48.7	5.1
50	49.7	5.2
51	50.7	5.3
52	51.7	5.4
53	52.7	5.5
54	53.7	5.6
55	54.7	5.7
56	55.7	5.8
57	56.7	5.9
58	57.7	6.1
59	58.7	6.2
60	59.7	6.3
61	60.7	6.4
62	61.7	6.5
63	62.7	6.6
64	63.7	6.7
65	64.6	6.8
66	65.6	6.9
67	66.6	7.0
68	67.6	7.1

Distances.	6 degr.	84 de.
	Latitude and Departure.	
69	68.6	7.2
70	69.6	7.3
1	70.6	7.4
72	71.6	7.5
73	72.6	7.6
74	73.6	7.7
75	74.6	7.8
76	75.6	7.9
77	76.6	8.0
78	77.6	8.1
79	78.6	8.2
80	79.6	8.3
81	80.6	8.5
82	81.5	8.6
83	82.5	8.7
84	83.5	8.8
85	84.5	8.9
86	85.5	9.0
87	86.5	9.1
88	87.5	9.2
89	88.5	9.3
90	89.5	9.4
91	90.5	9.5
92	91.5	9.6
93	92.5	9.7
94	93.5	9.8
95	94.5	9.9
96	95.5	10.0
97	96.5	10.1
98	97.5	10.2
99	98.5	10.3
100	99.5	10.4
200	198.9	20.9
300	298.3	31.3

Distances.	7 degr.	83 degr.
	Latitude and Departure.	
1	1.0	1
2	2.0	2
3	3.0	4
4	4.0	5
5	5.0	6
6	6.0	7
7	6.9	8
8	7.9	1.0
9	8.9	1.1
10	9.9	1.2
11	10.9	1.3
12	11.9	1.5
13	12.9	1.6
14	13.9	1.7
15	14.9	1.8
16	15.9	2.0
17	16.9	2.1
18	17.9	2.2
19	18.9	2.3
20	19.9	2.4
21	20.8	2.6
22	21.8	2.7
23	22.8	2.8
24	23.8	2.9
25	24.8	3.0
26	25.8	3.2
27	26.8	3.3
28	27.8	3.4
29	28.8	3.5
30	29.8	3.7
31	30.8	3.8
32	31.8	3.9
33	32.7	4.0
34	33.7	4.1

Distances.	7 degr.	83 degr.
	Latitude and Departure.	
35	34.7	4.3
36	35.7	4.4
37	36.7	4.5
38	37.7	4.6
39	38.7	4.8
40	39.7	4.9
41	40.7	5.0
42	41.7	5.1
43	42.7	5.2
44	43.7	5.4
45	44.7	5.5
46	45.6	5.6
47	46.6	5.7
48	47.6	5.9
49	48.6	6.0
50	49.6	6.1
51	50.6	6.2
52	51.6	6.3
53	52.6	6.5
54	53.6	6.6
55	54.6	6.7
56	55.6	6.8
57	56.6	6.9
58	57.6	7.1
59	58.6	7.2
60	59.6	7.3
61	60.5	7.4
62	61.5	7.6
63	62.5	7.7
64	63.5	7.8
65	64.5	7.9
66	65.5	8.1
67	66.5	8.2
68	67.5	8.3

Distances.	7 degr.	83 de.
	Latitude and Departure.	
69	68.5	8.4
70	69.5	8.5
71	70.5	8.7
72	71.5	8.8
73	72.5	8.9
74	73.4	9.0
75	74.4	9.2
76	75.4	9.3
77	76.4	9.4
78	77.4	9.5
79	78.4	9.6
80	79.4	9.8
81	80.4	9.9
82	81.4	10.0
83	82.4	10.1
84	83.4	10.3
85	84.4	10.4
86	85.4	10.5
87	86.3	10.6
88	87.3	10.7
89	88.3	10.9
90	89.3	11.0
91	90.3	11.1
92	91.3	11.2
93	92.3	11.3
94	93.3	11.5
95	94.3	11.6
96	95.3	11.7
97	96.3	11.8
98	97.3	12.0
99	98.3	12.1
100	99.3	12.2
200	198.5	24.4
300	297.8	26.6

Distance.	8 degr. Latitude and Departure.	82 degr. Latitude and Departure.
1	1.0	1
2	2.0	3
3	3.0	4
4	4.0	6
5	5.0	7
6	5.9	8
7	6.9	1.0
8	7.9	1.1
9	8.9	1.3
10	9.9	1.4
11	10.9	1.5
12	11.9	1.7
13	12.9	1.8
14	13.8	1.9
15	14.8	2.1
16	15.8	2.2
17	16.8	2.4
18	17.8	2.5
19	18.8	2.6
20	19.8	2.8
21	20.8	2.9
22	21.8	3.1
23	22.8	3.2
24	23.8	3.3
25	24.7	3.5
26	25.7	3.6
27	26.7	3.8
28	27.7	3.9
29	28.7	4.0
30	29.7	4.2
31	30.7	4.3
32	31.7	4.4
33	32.7	4.6
34	33.7	4.7
35	34.7	4.9
36	35.7	5.0
37	36.6	5.1
38	37.6	5.3
39	38.6	5.4
40	39.6	5.6
41	40.6	5.7
42	41.6	5.8
43	42.6	6.0
44	43.6	6.1
45	44.6	6.3
46	45.6	6.4
47	46.5	6.5
48	47.5	6.7
49	48.5	6.8
50	49.5	7.0
51	50.5	7.1
52	51.5	7.2
53	52.5	7.4
54	53.5	7.5
55	54.5	7.7
56	55.5	7.8
57	56.5	7.9
58	57.4	8.1
59	58.4	8.2
60	59.4	8.3
61	60.4	8.5
62	61.4	8.6
63	62.4	8.8
64	63.4	8.9
65	64.4	9.0
66	65.4	9.2
67	66.4	9.3
68	67.3	9.5
69	68.3	9.6
70	69.3	9.7
71	70.3	9.9
72	71.3	10.0
73	72.3	10.2
74	73.3	10.3
75	74.3	10.4
76	75.3	10.6
77	76.3	10.7
78	77.2	10.9
79	78.2	11.0
80	79.2	11.1
81	80.2	11.3
82	81.2	11.4
83	82.2	11.5
84	83.2	11.7
85	84.2	11.8
86	85.2	12.0
87	86.2	12.1
88	87.2	12.2
89	88.1	12.4
90	89.1	12.5
91	90.1	12.7
92	91.1	12.8
93	92.1	12.9
94	93.1	13.1
95	94.1	13.2
96	95.1	13.4
97	96.1	13.5
98	97.0	13.6
99	98.0	13.8
100	99.0	13.9
200	198.1	27.8
200	207.1	41.7

Distances.	9 degr.	81 degr.
	Latitude and Departure.	
1	1.0	2
2	2.0	3
3	3.0	5
4	4.0	6
5	4.9	8
6	5.9	9
7	6.9	1.1
8	7.9	1.3
9	8.9	1.4
10	9.9	1.6
11	10.9	1.7
12	11.9	1.9
13	12.9	2.0
14	13.8	2.2
15	14.8	2.3
16	15.8	2.5
17	16.8	2.6
18	17.8	2.8
19	18.8	3.0
20	19.8	3.1
21	20.8	3.3
22	21.7	3.4
23	22.7	3.6
24	23.7	3.7
25	24.7	3.9
26	25.7	4.1
27	26.7	4.2
28	27.7	4.4
29	28.7	4.5
30	29.6	4.7
31	30.6	4.8
32	31.6	5.0
33	32.6	5.1
34	33.6	5.3

Distances.	9 degr.	81 degr.
	Latitude and Departure.	
35	34.6	5.5
36	35.6	5.6
37	36.6	5.8
38	37.5	5.9
39	38.5	6.1
40	39.5	6.3
41	40.5	6.4
42	41.5	6.6
43	42.5	6.7
44	43.5	6.9
45	44.5	7.0
46	45.4	7.2
47	46.4	7.3
48	47.4	7.5
49	48.4	7.7
50	49.4	7.8
51	50.4	8.0
52	51.4	8.1
53	52.4	8.3
54	53.4	8.4
55	54.3	8.6
56	55.3	8.8
57	56.3	8.9
58	57.3	9.1
59	58.3	9.2
60	59.3	9.4
61	60.3	9.5
62	61.2	9.7
63	62.2	9.8
64	63.2	10.0
65	64.2	10.2
66	65.2	10.3
67	66.2	10.5
68	67.2	10.6

Distances.	9 degr.	82 de.
	Latitude and Departure.	
69	68.2	10.8
70	69.1	10.9
71	70.1	11.1
72	71.1	11.2
73	72.1	11.4
74	73.1	11.6
75	74.1	11.7
76	75.1	11.9
77	76.1	12.0
78	77.0	12.2
79	78.0	12.4
80	79.0	12.5
81	80.0	12.7
82	81.0	12.8
83	82.0	13.0
84	83.0	13.1
85	84.0	13.3
86	85.0	13.4
87	85.9	13.6
88	86.9	13.8
89	87.9	13.9
90	88.9	14.1
91	89.9	14.2
92	90.9	14.4
93	91.9	14.5
94	92.9	14.7
95	93.8	14.8
96	94.8	15.0
97	95.8	15.2
98	96.8	15.3
99	97.8	15.5
100	98.8	15.6
200	197.5	31.3
300	296.3	46.9

Distances.	10 deg.	80 degr.
	Latitude and Departure.	
1	1.0	2
2	2.0	3
3	3.0	5
4	3.9	7
5	4.9	9
6	5.9	1.0
7	6.9	1.2
8	7.9	1.4
9	8.9	1.6
10	9.9	1.7
11	10.8	1.9
12	11.8	2.1
13	12.8	2.3
14	13.8	2.4
15	14.8	2.6
16	15.8	2.8
17	16.8	3.0
18	17.7	3.1
19	18.7	3.3
20	19.7	3.5
21	20.7	3.6
22	21.7	3.8
23	22.7	4.0
24	23.6	4.2
25	24.6	4.3
26	25.6	4.5
27	26.6	4.7
28	27.6	4.9
29	28.6	5.0
30	29.6	5.2
31	30.5	5.4
32	31.5	5.5
33	32.5	5.7
34	33.5	5.9

Distances.	10 deg.	80 degr.
	Latitude and Departure.	
35	34.5	6.1
36	35.5	6.2
37	36.5	6.4
38	37.4	6.6
39	38.4	6.8
40	39.4	6.9
41	40.4	7.1
42	41.4	7.3
43	42.4	7.5
44	43.3	7.6
45	44.3	7.8
46	45.3	8.0
47	46.3	8.1
48	47.3	8.3
49	48.3	8.5
50	49.2	8.7
51	50.2	8.8
52	51.2	9.0
53	52.2	9.2
54	53.2	9.4
55	54.2	9.5
56	55.2	9.7
57	56.1	9.9
58	57.1	10.1
59	58.1	10.2
60	59.1	10.4
61	60.1	10.6
62	61.1	10.8
63	62.0	10.9
64	63.0	11.1
65	64.0	11.3
66	65.0	11.5
67	66.0	11.6
68	67.0	11.8

Distances.	10 deg.	80 de.
	Latitude and Departure.	
69	68.0	12.0
70	68.9	12.1
71	69.9	12.3
72	70.9	12.5
73	71.9	12.7
74	72.9	12.8
75	73.9	13.0
76	74.9	13.2
77	75.8	13.3
78	76.8	13.5
79	77.8	13.7
80	78.8	13.9
81	79.8	14.1
82	80.8	14.2
83	81.7	14.4
84	82.7	14.6
85	83.7	14.8
86	84.7	14.9
87	85.7	15.1
88	86.7	15.3
89	87.6	15.4
90	88.6	15.6
91	89.6	15.8
92	90.6	16.0
93	91.6	16.1
94	92.6	16.3
95	93.6	16.5
96	94.6	16.7
97	95.5	16.8
98	96.5	17.0
99	97.5	17.2
100	98.5	17.4
200	197.0	34.7
300	295.4	52.9

Distances.	11 deg.	79 degr.
	Latitude and Departure.	
1	1.0	2
2	2.0	4
3	2.9	6
4	3.9	8
5	4.9	9
6	5.9	1.1
7	6.9	1.3
8	7.8	1.5
9	8.8	1.7
10	9.8	1.9
11	10.8	2.1
12	11.8	2.3
13	12.8	2.5
14	13.7	2.7
15	14.7	2.9
16	15.7	3.0
17	16.7	3.2
18	17.7	3.4
19	18.6	3.6
20	19.6	3.8
21	20.6	4.0
22	21.6	4.2
23	22.6	4.4
24	23.6	4.6
25	24.5	4.8
26	25.5	5.0
27	26.5	5.1
28	27.5	5.3
29	28.5	5.5
30	29.4	5.7
31	30.4	5.9
32	31.4	6.1
33	32.4	6.3
34	33.4	6.5

Distances.	11 deg.	79 degr.
	Latitude and Departure.	
35	34.3	6.7
36	35.3	6.9
37	36.3	7.1
38	37.3	7.2
39	38.3	7.4
40	39.3	7.6
41	40.2	7.8
42	41.2	8.0
43	42.2	8.2
44	43.2	8.4
45	44.2	8.6
46	45.2	8.8
47	46.1	9.0
48	47.1	9.2
49	48.1	9.3
50	49.1	9.5
51	50.1	9.7
52	51.0	9.9
53	52.0	10.1
54	53.0	10.3
55	54.0	10.5
56	55.0	10.7
57	55.9	10.9
58	56.9	11.1
59	57.9	11.2
60	58.9	11.4
61	59.9	11.6
62	60.9	11.8
63	61.8	12.0
64	62.8	12.2
65	63.8	12.4
66	64.8	12.6
67	65.8	12.8
68	66.8	13.0

Distances.	11 deg.	79 de.
	Latitude and Departure.	
69	67.7	13.2
70	68.7	13.4
71	69.7	13.5
72	70.7	13.7
73	71.6	13.9
74	72.6	14.1
75	73.6	14.3
76	74.6	14.5
77	75.6	14.7
78	76.5	14.9
79	77.5	15.1
80	78.5	15.3
81	79.5	15.4
82	80.5	15.6
83	81.5	15.8
84	82.4	16.0
85	83.4	16.2
86	84.4	16.4
87	85.4	16.6
88	86.4	16.8
89	87.3	17.0
90	88.3	17.2
91	89.3	17.4
92	90.3	17.6
93	91.3	17.7
94	92.3	17.9
95	93.2	18.1
96	94.2	18.3
97	95.2	18.5
98	96.2	18.7
99	97.2	18.9
100	98.1	19.1
200	196.3	38.2
300	294.4	57.2

Distances.	12 deg.	78 degr.
	Latitude and Departure.	
1	1.0	2
2	2.0	4
3	2.9	6
4	3.9	8
5	4.9	1.0
6	5.9	1.2
7	6.8	1.5
8	7.8	1.7
9	8.8	1.9
10	9.8	2.1
11	10.8	2.3
12	11.7	2.5
13	12.7	2.7
14	13.7	2.9
15	14.7	3.1
16	15.6	3.3
17	16.6	3.6
18	17.6	3.8
19	18.6	4.0
20	19.6	4.2
21	20.5	4.4
22	21.5	4.6
23	22.5	4.8
24	23.5	5.0
25	24.5	5.2
26	25.4	5.4
27	26.4	5.6
28	27.4	5.8
29	28.4	6.0
30	29.3	6.2
31	30.3	6.4
32	31.3	6.6
33	32.3	6.9
34	33.3	7.1

Distances.	12 deg.	78 degr.
	Latitude and Departure.	
35	34.2	7.3
36	35.2	7.5
37	36.2	7.7
38	37.2	7.9
39	38.1	8.1
40	39.1	8.3
41	40.1	8.5
42	41.1	8.7
43	42.0	9.0
44	43.0	9.2
45	44.0	9.4
46	45.0	9.6
47	46.0	9.8
48	47.0	10.0
49	47.9	10.2
50	48.9	10.4
51	49.9	10.6
52	50.9	10.8
53	51.8	11.0
54	52.8	10.2
55	53.8	14.4
56	54.8	11.6
57	55.8	11.8
58	56.7	12.1
59	57.7	12.3
60	58.7	12.5
61	59.7	12.7
62	60.7	12.9
63	61.6	13.1
64	62.6	13.3
65	63.6	13.5
66	64.6	13.7
67	65.5	14.0
68	66.5	14.2

Distances.	12 deg.	87 de.
	Latitude and Departure.	
69	67.5	14.4
70	68.5	14.6
71	69.4	14.8
72	70.4	15.0
73	71.4	15.2
74	72.4	15.4
75	73.4	15.6
76	74.3	15.8
77	75.3	16.0
78	76.3	16.2
79	77.3	16.4
80	78.3	16.6
81	79.2	16.8
82	80.2	17.0
83	81.2	17.3
84	82.2	17.5
85	83.1	17.7
86	84.1	17.9
87	85.1	18.1
88	86.1	18.3
89	87.1	18.5
90	88.0	18.7
91	89.0	18.9
92	90.0	19.1
93	91.0	19.3
94	92.0	19.5
95	92.9	19.7
96	93.9	20.0
97	94.9	20.2
98	95.9	20.4
99	96.8	20.6
100	97.8	20.8
200	195.6	41.6
300	293.4	62.4

Distances.	13 deg.	77 degr.
	Latitude and Departure.	
1	1.0	2
2	2.0	4
3	2.9	7
4	3.9	9
5	4.9	1.1
6	5.9	1.3
7	6.8	1.6
8	7.8	1.8
9	8.8	2.0
10	9.8	2.2
11	10.7	2.5
12	11.7	2.7
13	12.7	2.9
14	13.6	3.1
15	14.6	3.4
16	15.6	3.6
17	16.6	3.8
18	17.6	4.0
19	18.5	4.3
20	19.5	4.5
21	20.5	4.7
22	21.5	4.9
23	22.4	5.2
24	23.4	5.4
25	24.4	5.6
26	25.4	5.8
27	26.3	6.1
28	27.3	6.3
29	28.3	6.5
30	29.2	6.7
31	30.2	7.0
32	31.2	7.2
33	32.2	7.4
34	33.1	7.6

Distances.	13 deg.	77 degr.
	Latitude and Departure.	
35	34.1	7.9
36	35.1	8.1
37	36.1	8.3
38	37.0	8.6
39	38.0	8.8
40	39.0	9.0
41	40.0	9.2
42	40.9	9.4
43	41.9	9.7
44	42.9	9.9
45	43.8	10.1
46	44.8	10.3
47	45.8	10.6
48	46.8	10.8
49	47.7	11.0
50	48.7	11.2
51	49.7	11.5
52	50.7	11.7
53	51.6	11.9
54	52.6	12.1
55	53.6	12.4
56	54.6	12.6
57	55.5	12.8
58	56.5	13.0
59	57.5	13.3
60	58.5	13.5
61	59.4	13.7
62	60.4	14.0
63	61.4	14.2
64	62.4	14.4
65	63.4	14.6
66	64.3	14.8
67	65.3	15.1
68	66.3	15.3

Distances.	13 deg.	77 de.
	Latitude and Departure.	
69	67.2	15.5
70	68.2	15.7
71	69.2	16.0
72	70.2	16.2
73	71.1	16.4
74	72.1	16.6
75	73.1	16.9
76	74.1	17.1
77	75.0	17.3
78	76.0	17.5
79	77.0	17.8
80	78.0	18.0
81	78.9	18.2
82	79.9	18.4
83	80.9	18.7
84	81.8	18.9
85	82.8	19.1
86	83.8	19.3
87	84.8	19.6
88	85.7	19.8
89	86.7	20.0
90	87.7	20.2
91	88.7	20.5
92	89.6	20.7
93	90.6	20.9
94	91.6	21.1
95	92.6	21.4
96	93.5	21.6
97	94.5	21.8
98	95.5	22.1
99	96.5	22.3
100	97.4	22.5
200	194.9	45.0
300	292.3	67.5

Distances.	14 deg.	76 degr.
	Latitude and Departure.	
1	1.0	2.
2	1.9	5
3	2.9	7
4	3.9	1.0
5	4.8	1.2
6	5.8	1.4
7	6.8	1.7
8	7.8	1.9
9	8.7	2.2
10	9.7	2.4
11	10.7	2.7
12	11.6	2.9
13	12.6	3.1
14	13.6	3.4
15	14.6	3.6
16	15.5	3.9
17	16.5	4.1
18	17.5	4.4
19	18.4	4.6
20	19.4	4.8
21	20.4	5.1
22	21.3	5.3
23	22.3	5.6
24	23.3	5.8
25	24.2	6.0
26	25.2	6.3
27	26.2	6.5
28	27.2	6.8
29	28.1	7.0
30	29.1	7.3
31	30.1	7.5
32	31.0	7.7
33	32.0	8.0
34	33.0	8.2

Distances.	14 deg.	76 degr.
	Latitude and Departure.	
35	34.0	8.5
36	34.9	8.7
37	35.9	9.0
38	36.9	9.2
39	37.8	9.4
40	38.8	9.7
41	39.8	9.9
42	40.7	10.2
43	41.7	10.4
44	42.7	10.7
45	43.7	10.9
46	44.6	11.1
47	45.6	11.4
48	46.6	11.6
49	47.5	11.9
50	48.5	12.1
51	49.5	12.3
52	50.4	12.6
53	51.4	12.8
54	52.4	13.1
55	53.4	13.3
56	54.3	13.6
57	55.3	13.8
58	56.3	14.0
59	57.2	14.3
60	58.2	14.5
61	59.2	14.8
62	60.1	15.0
63	61.1	15.3
64	62.1	15.5
65	63.1	15.7
66	64.0	16.0
67	65.0	16.2
68	66.0	16.5

Distances.	14 deg.	76 de.
	Latitude and Departure.	
69	66.9	16.7
70	67.9	16.9
71	68.9	17.2
72	69.8	17.4
73	70.8	17.7
74	71.8	17.9
75	72.8	18.2
76	73.7	18.4
77	74.7	18.7
78	75.7	18.9
79	76.6	19.1
80	77.6	19.4
81	78.6	19.5
82	79.6	19.7
83	80.5	20.0
84	81.5	20.2
85	82.5	20.5
86	83.4	20.7
87	84.4	20.9
88	85.4	21.3
89	86.4	21.5
90	87.3	21.8
91	88.3	22.0
92	89.3	22.3
93	90.2	22.5
94	91.2	22.7
95	92.1	23.0
96	93.1	23.2
97	94.1	23.5
98	95.1	23.7
99	96.0	24.0
100	97.0	24.2
200	194.1	48.4
300	291.1	72.6

Distances.	15 deg.	75 degr.
	Latitude and Departure.	
1	1.0	.3
2	1.9	.5
3	2.9	.8
4	3.9	1.0
5	4.8	1.3
6	5.8	1.6
7	6.8	1.8
8	7.7	2.1
9	8.7	2.3
10	9.7	2.6
11	10.6	2.8
12	11.6	3.1
13	12.6	3.4
14	13.5	3.6
15	14.5	3.9
16	15.5	4.1
17	16.4	4.4
18	17.4	4.7
19	18.3	4.9
20	19.3	5.2
21	20.3	5.4
22	21.3	5.7
23	22.2	6.0
24	23.2	6.2
25	24.2	6.5
26	25.1	6.7
27	26.1	7.0
28	27.1	7.3
29	28.0	7.5
30	29.0	7.8
31	29.9	8.0
32	30.9	8.3
33	31.9	8.5
34	32.8	8.8

Distances.	15 deg.	75 degr.
	Latitude and Departure.	
35	33.8	9.1
36	34.8	9.3
37	35.7	9.6
38	36.7	9.8
39	37.7	10.1
40	38.6	10.3
41	39.6	10.6
42	40.6	10.9
43	41.5	11.1
44	42.5	11.4
45	43.5	11.6
46	44.4	11.9
47	45.4	12.3
48	46.4	12.5
49	47.3	12.8
50	48.3	12.9
51	49.3	13.2
52	50.2	13.5
53	51.2	13.7
54	52.2	14.0
55	53.1	14.2
56	54.1	14.5
57	55.1	14.8
58	56.0	15.0
59	57.0	15.3
60	58.0	15.5
61	58.9	15.8
62	59.9	16.0
63	60.8	16.3
64	61.8	16.6
65	62.8	16.8
66	63.8	17.1
67	64.7	17.4
68	65.7	17.6

Distances.	15 deg.	75 de.
	Latitude and Departure.	
69	66.6	17.9
70	67.6	18.1
71	68.6	18.4
72	69.6	18.6
73	70.5	18.9
74	71.5	19.2
75	72.4	19.4
76	73.4	19.7
77	74.4	20.0
78	75.4	20.2
79	76.3	20.5
80	77.3	20.7
81	78.3	21.0
82	79.2	21.2
83	80.2	21.5
84	81.1	21.7
85	82.1	22.0
86	83.1	22.3
87	84.0	22.5
88	85.0	22.8
89	86.0	23.0
90	86.9	23.3
91	87.9	23.6
92	88.9	23.8
93	89.8	24.1
94	90.8	24.3
95	91.8	24.6
96	92.7	24.8
97	93.7	25.1
98	94.7	25.4
99	95.6	25.6
100	96.6	25.9
200	193.2	51.8
300	289.8	77.6

Distances.	16 deg.	74 degr.
	Latitude and Departure.	
1	1.0	3
2	1.9	6
3	2.9	8
4	3.8	1.1
5	4.8	1.4
6	5.8	1.7
7	6.7	1.9
8	7.7	2.2
9	8.6	2.5
10	9.6	2.8
11	10.6	3.0
12	11.5	3.3
13	12.5	3.6
14	13.4	3.9
15	14.4	4.1
16	15.4	4.4
17	16.3	4.7
18	17.3	5.0
19	18.3	5.3
20	19.2	5.5
21	20.2	5.8
22	21.1	6.1
23	22.2	6.3
24	23.1	6.6
25	24.0	6.9
26	25.0	7.2
27	25.9	7.5
28	26.9	7.7
29	27.9	8.0
30	28.8	8.3
31	29.8	8.5
32	30.8	8.8
33	31.7	9.1
34	32.7	9.4

Distances.	16 deg.	74 degr.
	Latitude and Departure.	
35	33.6	9.7
36	34.6	9.9
37	35.6	10.2
38	36.5	10.5
39	37.5	10.7
40	38.4	11.0
41	39.4	11.3
42	40.4	11.6
43	41.3	11.9
44	42.3	12.1
45	43.2	12.4
46	44.2	12.7
47	45.2	13.0
48	46.1	13.2
49	47.1	13.5
50	48.1	13.8
51	49.0	14.1
52	50.0	14.3
53	50.9	14.6
54	51.9	14.9
55	52.9	15.1
56	53.8	15.4
57	54.8	15.7
58	55.7	16.0
59	56.7	16.3
60	57.7	16.5
61	58.6	16.8
62	59.6	17.1
63	60.6	17.4
64	61.5	17.7
65	62.5	17.9
66	63.4	18.2
67	64.4	18.5
68	65.4	18.8

Distances.	16 deg.	74 de.
	Latitude and Departure.	
69	66.3	19.0
70	67.3	19.3
71	68.2	19.6
72	69.2	19.9
73	70.2	20.1
74	71.1	20.4
75	72.1	20.7
76	73.1	21.0
77	74.0	21.3
78	75.0	21.5
79	75.9	21.8
80	76.9	22.0
81	77.9	22.3
82	78.8	22.6
83	79.8	22.9
84	80.7	23.2
85	81.7	23.5
86	82.7	23.7
87	83.6	24.0
88	84.6	24.3
89	85.6	24.5
90	86.5	24.8
91	87.5	25.1
92	88.4	25.4
93	89.4	25.7
94	90.4	25.9
95	91.3	26.2
96	92.3	26.5
97	93.2	26.7
98	94.2	27.0
99	95.2	27.3
100	96.1	27.6
200	192.3	55.1
300	288.4	82.7

Distances.	17 deg.	73 degr.
	Latitude and Departure.	
1	1.0	3
2	1.9	6
3	2.9	9
4	3.8	1.2
5	4.8	1.5
6	5.7	1.7
7	6.7	2.0
8	7.6	2.3
9	8.6	2.6
10	9.6	2.9
11	10.5	3.2
12	11.5	3.5
13	12.4	3.8
14	13.4	4.1
15	14.3	4.4
16	15.3	4.7
17	16.2	5.0
18	17.2	5.2
19	18.2	5.5
20	19.1	5.8
21	20.1	6.1
22	21.0	6.4
23	22.0	6.7
24	23.0	7.0
25	23.9	7.3
26	24.9	7.6
27	25.8	7.9
28	26.8	8.2
29	27.7	8.5
30	28.7	8.8
31	29.6	9.1
32	30.6	9.3
33	31.6	9.6
34	32.5	9.9

Distances.	17 deg.	73 degr.
	Latitude and Departure.	
35	33.5	10.2
36	34.4	10.5
37	35.4	10.8
38	36.3	11.1
39	37.3	11.4
40	38.3	11.7
41	39.2	12.0
42	40.2	12.3
43	41.1	12.6
44	42.1	12.9
45	43.0	13.1
46	44.0	13.4
47	44.9	13.7
48	45.9	14.0
49	46.9	14.3
50	47.8	14.6
51	48.8	14.9
52	49.7	15.2
53	50.7	15.5
54	51.6	15.8
55	52.6	16.1
56	53.5	16.4
57	54.5	16.7
58	55.4	17.0
59	56.4	17.2
60	57.4	17.5
61	58.3	17.8
62	59.3	18.1
63	60.2	18.4
64	61.2	18.7
65	62.2	19.0
66	63.1	19.3
67	64.1	19.6
68	65.0	19.9

Distances.	17 deg.	73 deg.
	Latitude and Departure.	
69	66.0	20.2
70	67.9	20.5
71	67.9	20.7
72	68.8	21.0
73	69.8	21.3
74	70.8	21.6
75	71.7	21.9
76	72.7	22.2
77	73.6	22.5
78	74.6	22.8
79	75.5	23.1
80	76.5	23.4
81	77.5	23.7
82	78.4	24.0
83	79.4	24.3
84	80.3	24.6
85	81.3	24.8
86	82.2	25.1
87	83.2	25.4
88	84.2	25.7
89	85.1	26.0
90	86.1	26.3
91	87.0	26.6
92	88.0	26.9
93	88.9	27.2
94	89.9	27.5
95	90.8	27.8
96	91.8	28.1
97	92.7	28.4
98	93.7	28.7
99	94.7	28.9
100	95.6	29.2
200	191.3	58.5
300	286.9	87.7

Distances.	18 deg.	72 degr.
	Latitude and Departure.	
1	1.0	3
2	1.9	6
3	2.8	9
4	3.8	1.2
5	4.7	1.5
6	5.7	1.8
7	6.6	2.2
8	7.6	2.5
9	8.5	2.8
10	9.5	3.1
11	10.4	3.4
12	11.4	3.7
13	12.3	4.0
14	13.3	4.3
15	14.2	4.6
16	15.2	5.0
17	16.1	5.3
18	17.1	5.6
19	18.0	5.9
20	19.0	6.2
21	20.0	6.5
22	20.9	6.8
23	21.9	7.1
24	22.8	7.4
25	23.8	7.7
26	24.7	8.1
27	25.7	8.4
28	26.6	8.7
29	27.6	9.0
30	28.5	9.3
31	29.5	9.6
32	30.4	9.9
33	31.4	10.2
34	32.3	10.5

Distances.	18 deg.	72 degr.
	Latitude and Departure.	
35	33.3	10.8
36	34.2	11.1
37	35.2	11.4
38	36.1	11.7
39	37.1	12.0
40	38.0	12.4
41	39.0	12.7
42	39.8	13.0
43	40.8	13.3
44	41.7	13.6
45	42.7	13.9
46	43.6	14.2
47	44.6	14.5
48	45.5	14.8
49	46.5	15.1
50	47.6	15.4
51	48.5	15.8
52	49.5	16.1
53	50.4	16.4
54	51.4	16.7
55	52.3	17.0
56	53.3	17.3
57	54.2	17.6
58	55.2	17.9
59	56.1	18.2
60	57.1	18.5
61	58.0	18.8
62	59.6	19.2
63	59.9	19.5
64	60.9	19.8
65	61.8	20.1
66	62.8	20.4
67	63.7	20.7
68	64.7	21.0

Distances.	18 deg.	72 deg.
	Latitude and Departure.	
69	65.6	21.3
70	66.6	21.6
71	67.5	21.9
72	68.5	22.2
73	69.4	22.5
74	70.4	22.9
75	71.3	23.2
76	72.3	23.5
77	73.2	23.8
78	74.2	24.1
79	75.1	24.4
80	76.1	24.7
81	77.0	25.0
82	78.0	25.3
83	78.9	25.6
84	79.9	26.0
85	80.8	26.3
86	81.8	26.6
87	82.7	26.9
88	83.7	27.2
89	84.6	27.5
90	85.6	27.8
91	86.5	28.1
92	87.5	28.4
93	88.4	28.7
94	89.4	29.0
95	90.3	29.3
96	91.3	29.7
97	92.2	30.0
98	93.2	30.3
99	94.1	30.6
100	95.1	30.9
200	190.2	61.8
300	285.3	92.7

Distances.	19 deg.	71 degr.
	Latitude and Departure.	
1	9	3
2	1.9	6
3	2.8	1.0
4	3.8	1.3
5	4.7	1.6
6	5.7	2.0
7	6.6	2.3
8	7.5	2.6
9	8.5	2.9
10	9.4	3.3
11	10.4	3.6
12	11.3	3.9
13	12.3	4.2
14	13.2	4.5
15	14.2	4.9
16	15.1	5.2
17	16.1	5.5
18	17.0	5.9
19	18.0	6.2
20	18.9	6.5
21	19.9	6.8
22	20.8	7.2
23	21.7	7.5
24	22.7	7.8
25	23.6	8.2
26	24.6	8.5
27	25.5	8.8
28	26.5	9.1
29	27.4	9.4
30	28.4	9.8
31	29.3	10.1
32	30.3	10.4
33	31.2	10.7
34	32.1	11.1

Distances.	19 deg.	71 degr.
	Latitude and Departure.	
35	33.1	11.4
36	34.0	11.7
37	35.0	12.1
38	35.9	12.4
39	36.9	12.7
40	37.8	13.0
41	38.8	13.4
42	39.7	13.7
43	40.7	14.0
44	41.6	14.3
45	42.5	14.7
46	43.5	15.0
47	44.4	15.3
48	45.4	15.6
49	46.3	15.9
50	47.3	16.3
51	48.2	16.6
52	49.2	16.9
53	50.1	17.3
54	51.0	17.6
55	52.0	17.9
56	52.9	18.2
57	53.9	18.6
58	54.8	18.9
59	55.8	19.2
60	56.7	19.5
61	57.7	19.9
62	58.6	20.2
63	59.6	20.5
64	60.5	20.8
65	61.5	21.2
66	62.4	21.5
67	63.4	21.8
68	64.3	22.2

Distances.	19 deg.	71 deg.
	Latitude and Departure.	
69	65.2	22.5
70	66.2	22.8
71	67.1	23.1
72	68.1	23.4
73	69.0	23.8
74	69.9	24.1
75	70.9	24.4
76	71.8	24.7
77	72.8	25.1
78	73.7	25.4
79	74.7	25.7
80	75.6	26.1
81	76.6	26.4
82	77.5	26.7
83	78.5	27.0
84	79.4	27.4
85	80.4	27.7
86	81.3	28.0
87	82.2	28.3
88	83.2	28.7
89	84.1	29.0
90	85.1	29.3
91	86.0	29.6
92	87.0	30.0
93	87.9	30.3
94	88.9	30.6
95	89.8	30.9
96	90.8	31.3
97	91.7	31.6
98	92.6	31.9
99	93.6	32.2
100	94.5	32.6
200	189.1	65.1
300	283.6	97.7

Distances.	20 deg.	70 degr.
	Latitude and Departure.	
1	.9	.3
2	1.9	.7
3	2.8	1.0
4	3.8	1.4
5	4.7	1.7
6	5.6	2.0
7	6.6	2.4
8	7.5	2.7
9	8.5	3.1
10	9.4	3.4
11	10.3	3.8
12	11.3	4.1
13	12.2	4.4
14	13.2	4.8
15	14.1	5.1
16	15.0	5.5
17	16.0	5.8
18	16.9	6.1
19	17.9	6.5
20	18.8	6.8
21	19.7	7.2
22	20.7	7.5
23	21.6	7.9
24	22.6	8.2
25	23.5	8.5
26	24.4	8.9
27	25.4	9.2
28	26.3	9.6
29	27.2	10.0
30	28.2	10.3
31	29.1	10.6
32	30.1	10.9
33	31.0	11.3
34	31.9	11.6

Distances.	20 deg.	70 deg.
	Latitude and Departure.	
35	32.9	12.0
36	33.8	12.3
37	34.8	12.6
38	35.7	13.0
39	36.6	13.3
40	37.6	13.7
41	38.5	14.0
42	39.5	14.4
43	40.4	14.7
44	41.3	15.0
45	42.3	15.4
46	43.2	15.7
47	44.2	16.1
48	45.1	16.4
49	46.0	16.8
50	47.0	17.1
51	47.9	17.4
52	48.9	17.8
53	49.8	18.1
54	50.7	18.5
55	51.7	18.8
56	52.6	19.1
57	53.6	19.5
58	54.5	19.8
59	55.5	20.2
60	56.4	20.5
61	57.3	20.9
62	58.3	21.2
63	59.2	21.5
64	60.1	21.9
65	61.1	22.2
66	62.0	22.6
67	63.0	22.9
68	63.9	23.3

Distances.	20 deg.	70 deg.
	Latitude and Departure.	
69	64.8	23.6
70	65.8	23.9
71	66.7	24.3
72	67.7	24.6
73	68.6	24.9
74	69.5	25.3
75	71.5	25.6
76	71.4	26.0
77	72.4	26.3
78	73.3	26.7
79	74.2	27.0
80	75.2	27.4
81	76.1	27.7
82	77.1	28.0
83	78.0	28.4
84	78.9	28.7
85	80.0	29.1
86	80.8	29.4
87	81.8	29.8
88	82.7	30.1
89	83.6	30.4
90	84.6	30.8
91	85.5	31.1
92	86.4	31.5
93	87.4	31.8
94	88.3	32.1
95	89.3	32.5
96	90.2	32.8
97	91.2	33.2
98	92.1	33.5
99	93.0	33.9
100	94.0	34.2
200	187.9	63.4
300	281.9	102.6

Distances.	21 deg.	69 degr.
	Latitude and Departure.	
1	9	4
2	1.9	7
3	2.8	1.1
4	3.7	1.4
5	4.7	1.4
6	5.6	2.1
7	6.5	2.5
8	7.5	2.9
9	8.4	3.2
10	9.3	3.6
11	10.3	3.9
12	11.2	4.3
13	12.1	4.7
14	13.1	5.0
15	14.0	5.4
16	14.9	5.7
17	15.9	6.1
18	16.8	6.4
19	17.7	6.8
20	18.7	7.2
21	19.6	7.5
22	20.5	7.9
23	21.5	8.2
24	22.4	8.6
25	23.3	9.0
26	24.3	9.3
27	25.2	9.7
28	26.1	10.0
29	27.1	10.4
30	28.0	10.7
31	28.9	11.1
32	29.9	11.5
33	30.8	11.8
34	31.7	12.2

Distances.	21 deg.	69 degr.
	Latitude and Departure.	
35	32.7	12.5
36	33.6	12.9
37	34.5	13.2
38	35.5	13.6
39	36.4	14.0
40	37.3	14.3
41	38.3	14.7
42	39.2	15.0
43	40.1	15.4
44	41.1	15.8
45	42.0	16.1
46	42.9	16.5
47	43.9	16.8
48	44.8	17.2
49	45.7	17.6
50	46.7	17.9
51	47.6	18.3
52	48.5	18.6
53	49.5	19.0
54	50.4	19.3
55	51.3	19.7
56	52.3	20.1
57	53.2	20.4
58	54.1	20.8
59	55.1	21.1
60	56.0	21.5
61	56.9	21.9
62	57.9	22.2
63	58.8	22.6
64	59.8	22.9
65	60.7	23.3
66	61.6	23.6
67	62.6	24.0
68	63.5	24.4

Distances.	21 deg.	69 deg.
	Latitude and Departure.	
69	64.4	24.7
70	65.3	25.1
71	66.3	25.4
72	67.2	25.8
73	68.1	26.2
74	69.1	26.5
75	70.0	26.9
76	70.9	27.2
77	71.9	27.6
78	72.8	27.9
79	73.7	28.3
80	74.7	28.7
81	75.6	29.0
82	76.6	29.4
83	77.5	29.7
84	78.4	30.1
85	79.4	30.5
86	80.3	30.8
87	81.2	31.2
88	82.2	31.5
89	83.1	31.9
90	84.0	32.3
91	84.9	32.6
92	85.9	33.0
93	86.8	33.3
94	87.7	33.7
95	88.8	34.0
96	89.6	34.4
97	90.5	34.8
98	91.5	35.1
99	92.4	35.5
100	93.4	35.8
200	186.7	71.7
300	280.1	107.5

Distances.	22 deg. Latitude	68 degr. Departure.
1	9	4
2	1.9	7
3	2.8	1.1
4	3.7	1.5
5	4.6	1.9
6	5.6	2.2
7	6.5	2.6
8	7.4	3.0
9	8.3	3.4
10	9.3	3.7
11	10.2	4.1
12	11.1	4.5
13	12.0	4.9
14	13.0	5.2
15	13.9	5.6
16	14.8	6.0
17	15.7	6.4
18	16.7	6.7
19	17.6	7.1
20	18.5	7.5
21	19.5	7.9
22	20.4	8.2
23	21.3	8.6
24	22.2	9.0
25	23.2	9.4
26	24.1	9.7
27	25.0	10.1
28	26.0	10.5
29	26.9	10.9
30	27.8	11.2
31	28.7	11.6
32	29.7	12.0
33	30.6	12.4
34	31.5	12.7

Distances.	22 deg. Latitude	69 degr. Departure.
35	32.4	13.1
36	33.4	13.5
37	34.3	13.9
38	35.2	14.2
39	36.1	14.6
40	37.1	15.0
41	38.0	15.4
42	38.9	15.7
43	39.9	16.1
44	40.8	16.5
45	41.7	16.9
46	42.6	17.2
47	43.6	17.6
48	44.5	18.0
49	45.4	18.4
50	46.4	18.7
51	47.3	19.1
52	48.2	19.5
53	49.1	19.9
54	50.1	20.2
55	51.0	20.6
56	51.9	21.0
57	52.9	21.4
58	53.8	21.7
59	54.7	22.1
60	55.6	22.5
61	56.6	22.9
62	57.5	23.2
63	58.4	23.6
64	59.4	24.0
65	60.3	24.4
66	61.2	24.7
67	62.1	25.1
68	63.1	25.5

Distances.	22 deg. Latitude	69 deg. Departure.
69	64.0	25.9
70	64.9	26.2
71	65.8	26.6
72	66.7	27.0
73	67.7	27.4
74	68.6	27.7
75	69.5	28.1
76	70.5	28.5
77	71.4	29.9
78	72.3	29.2
79	73.3	29.6
80	74.2	30.1
81	75.1	30.4
82	76.0	30.7
83	77.0	31.1
84	77.9	31.5
85	78.8	31.9
86	79.7	32.2
87	80.6	32.6
88	81.6	33.0
89	82.5	33.4
90	83.4	33.7
91	84.4	34.1
92	85.3	34.5
93	86.2	34.9
94	87.1	35.2
95	88.1	35.6
96	89.0	36.0
97	89.9	36.4
98	90.9	36.7
99	91.8	37.1
100	92.7	37.5
200	185.4	74.9
300	278.2	112.4

Distances.	23 deg.	67 degr.
	Latitude and Departure.	
1	9	4
2	1.8	8
3	2.8	1.2
4	3.7	1.6
5	4.6	1.9
6	5.5	2.3
7	6.4	2.7
8	7.4	3.1
9	8.3	3.5
10	9.2	3.9
11	10.1	4.3
12	11.0	4.7
13	12.0	5.1
14	12.9	5.5
15	13.8	5.9
16	14.7	6.2
17	15.6	6.6
18	16.6	7.0
19	17.5	7.4
20	18.4	7.8
21	19.3	8.2
22	20.2	8.6
23	21.2	9.0
24	22.1	9.4
25	23.0	9.8
26	24.0	10.2
27	24.8	10.5
28	25.8	10.9
29	26.7	11.3
30	27.6	11.7
31	28.5	12.1
32	29.4	12.5
33	30.4	12.9
34	31.3	13.3

Distances.	23 deg.	67 degr.
	Latitude and Departure.	
35	32.2	13.7
36	33.1	14.1
37	34.0	14.4
38	35.0	14.8
39	35.9	15.2
40	36.8	15.6
41	37.7	16.0
42	38.6	16.4
43	39.6	16.8
44	40.5	17.2
45	41.4	17.6
46	42.3	18.0
47	43.3	18.4
48	44.2	18.7
49	45.1	19.1
50	46.0	19.5
51	46.9	19.9
52	47.9	20.3
53	48.8	20.7
54	49.7	21.1
55	50.6	21.5
56	51.5	21.9
57	52.4	22.3
58	53.4	22.6
59	54.3	23.0
60	55.2	23.4
61	56.1	23.8
62	57.1	24.2
63	58.0	24.6
64	58.9	25.0
65	59.8	25.4
66	60.8	25.8
67	61.8	26.2
68	62.6	26.6

Distances.	23 deg.	67 deg.
	Latitude and Departure.	
69	63.5	26.9
70	64.4	27.3
71	65.3	27.7
72	66.3	28.1
73	67.2	28.5
74	68.1	28.9
75	69.0	29.3
76	69.9	29.7
77	70.9	30.1
78	71.8	30.5
79	72.7	30.8
80	73.6	31.2
81	74.6	31.6
82	75.5	32.0
83	76.4	32.4
84	77.3	32.8
85	78.2	33.2
86	79.2	33.6
87	80.1	34.0
88	81.0	34.4
89	81.9	34.8
90	82.8	35.2
91	83.8	35.6
92	84.7	36.0
93	85.6	36.3
94	86.5	36.7
95	87.4	37.0
96	88.4	37.5
97	89.3	37.9
98	90.2	38.3
99	91.1	38.7
100	92.0	39.1
200	184.1	78.1
300	276.1	117.2

Distances.	24 deg.	66 degr.
	Latitude and Departure.	
1	9	4
2	1.8	8
3	2.7	1.2
4	3.6	1.6
5	4.6	2.0
6	5.5	2.4
7	6.4	2.8
8	7.3	3.2
9	8.2	3.7
10	9.1	4.1
11	10.0	4.5
12	10.9	4.9
13	11.9	5.3
14	12.8	5.7
15	13.7	6.1
16	14.6	6.5
17	15.5	6.9
18	16.4	7.3
19	17.3	7.7
20	18.3	8.1
21	19.2	8.5
22	20.1	9.0
23	21.0	9.4
24	21.9	9.8
25	22.8	10.2
26	23.7	10.6
27	24.6	11.0
28	25.6	11.3
29	26.5	11.7
30	27.4	12.2
31	28.3	12.6
32	29.2	13.0
33	30.1	13.4
34	31.0	13.8
35	32.0	14.2
36	32.9	14.6
37	33.8	15.1
38	34.7	15.5
39	35.6	15.9
40	36.5	16.3
41	37.4	16.7
42	38.4	17.1
43	39.3	17.5
44	40.2	17.9
45	41.1	18.3
46	42.0	18.7
47	42.9	19.1
48	43.8	19.5
49	44.8	19.9
50	45.7	20.3
51	46.6	20.7
52	47.5	21.1
53	48.4	21.6
54	49.3	22.0
55	50.2	22.4
56	51.1	22.8
57	52.1	23.2
58	53.0	23.6
59	53.9	24.0
60	54.8	24.4
61	55.7	24.8
62	56.6	25.2
63	57.5	25.6
64	58.5	26.0
65	59.4	26.4
66	60.3	26.8
67	61.2	27.2
68	62.1	27.6
69	63.0	28.1
70	63.9	28.5
71	64.8	28.9
72	65.8	29.3
73	66.7	29.7
74	67.6	30.1
75	68.5	30.5
76	69.4	30.9
77	70.3	31.3
78	71.2	31.7
79	72.1	32.1
80	73.1	32.5
81	74.0	32.9
82	74.9	33.3
83	75.8	33.7
84	76.7	34.1
85	77.6	34.5
86	78.5	34.9
87	79.5	35.3
88	80.4	35.7
89	81.3	36.2
90	82.2	36.6
91	83.1	37.0
92	84.0	37.4
93	84.9	37.8
94	85.8	38.2
95	86.8	38.6
96	87.7	39.0
97	88.6	39.5
98	89.5	39.9
99	90.4	40.3
100	91.3	40.7
200	182.7	81.3
300	274.0	122.0

Distances.	25 deg.	65 degr.
	Latitude and Departure.	
1	9	4
2	1.8	8
3	2.7	1.3
4	3.6	1.7
5	4.5	2.1
6	5.4	2.5
7	6.3	3.0
8	7.2	3.4
9	8.1	3.8
10	9.1	4.2
11	10.0	4.7
12	10.9	5.1
13	11.8	5.5
14	12.7	5.9
15	13.6	6.3
16	14.5	6.8
17	15.4	7.2
18	16.3	7.6
19	17.2	8.0
20	18.1	8.4
21	19.0	8.9
22	19.9	9.3
23	20.8	9.7
24	21.8	10.1
25	22.7	10.6
26	23.6	11.0
27	24.5	11.4
28	25.4	11.8
29	26.3	12.3
30	27.2	12.7
31	28.1	13.1
32	29.0	13.5
33	29.9	14.0
34	30.8	14.4

Distances.	25 deg.	65 degr.
	Latitude and Departure.	
35	31.7	14.8
36	32.6	15.2
37	33.5	15.6
38	34.4	16.1
39	35.3	16.5
40	36.2	16.9
41	37.2	17.3
42	38.1	17.8
43	39.0	18.2
44	39.9	18.6
45	40.8	19.0
46	41.7	19.5
47	42.6	19.9
48	43.5	20.3
49	44.4	20.7
50	45.3	21.1
51	46.2	21.6
52	47.1	22.0
53	48.0	22.4
54	48.9	22.8
55	49.8	23.2
56	50.7	23.7
57	51.6	24.1
58	52.6	24.5
59	53.5	25.0
60	54.4	25.4
61	55.3	25.8
62	56.2	26.2
63	57.1	26.7
64	58.0	27.1
65	58.9	27.5
66	59.8	27.9
67	60.7	28.3
68	61.6	28.8

Distances.	25 deg.	65 deg.
	Latitude and Departure.	
69	62.5	29.2
70	63.4	29.6
71	64.3	30.0
72	65.2	30.5
73	66.2	30.9
74	67.1	31.3
75	68.0	31.7
76	68.9	32.1
77	69.8	32.6
78	70.7	33.0
79	71.6	33.4
80	72.5	33.8
81	73.4	34.3
82	74.3	34.7
83	75.2	35.1
84	76.1	35.5
85	77.0	36.0
86	77.9	36.4
87	78.8	36.8
88	79.7	37.2
89	80.7	37.6
90	81.6	38.0
91	82.5	38.4
92	83.4	38.9
93	84.3	39.3
94	85.2	39.7
95	86.1	40.1
96	87.0	40.6
97	87.9	41.0
98	88.8	41.4
99	89.7	41.8
100	90.6	42.3
200	181.3	84.5
300	271.9	126.8

*

Distances.	26 deg.	64 degr.
	Latitude and Departure.	
1	9	4
2	1.8	9
3	2.7	1.3
4	3.6	1.8
5	4.5	2.2
6	5.4	2.6
7	6.3	3.1
8	7.2	3.5
9	8.1	3.9
10	9.0	4.4
11	9.9	4.8
12	10.8	5.3
13	11.7	5.7
14	12.6	6.1
15	13.5	6.6
16	14.4	7.0
17	15.3	7.4
18	16.2	7.9
19	17.1	8.3
20	18.0	8.8
21	18.9	9.2
22	19.8	9.6
23	20.7	10.1
24	21.6	10.5
25	22.5	10.9
26	23.4	11.4
27	24.3	11.8
28	25.2	12.3
29	26.1	12.7
30	27.0	13.1
31	27.9	13.6
32	28.8	14.0
33	29.7	14.4
34	30.6	14.9

Distances.	26 deg.	64 degr.
	atitude and Departure.	
35	31.5	15.3
36	32.4	15.8
37	33.3	16.2
38	34.2	16.6
39	35.1	17.1
40	36.0	17.5
41	36.8	17.9
42	37.8	18.4
43	38.9	18.8
44	39.5	19.3
45	40.4	19.7
46	41.3	20.2
47	42.2	20.6
48	43.1	21.0
49	44.0	21.4
50	44.9	21.9
51	45.8	22.3
52	46.7	22.8
53	47.6	23.2
54	48.5	23.7
55	49.4	24.1
56	50.3	24.5
57	51.2	25.0
58	52.1	25.4
59	53.0	25.8
60	53.9	26.3
61	54.8	26.7
62	55.7	27.2
63	56.6	27.6
64	57.5	28.0
65	58.4	28.5
66	59.3	28.9
67	60.2	29.4
68	61.1	29.8

Distances.	26 deg.	64 deg.
	Latitude and Departure.	
69	62.0	30.2
70	62.9	30.7
71	63.8	31.1
72	64.7	31.6
73	65.6	32.0
74	66.5	32.4
75	67.4	32.9
76	68.3	33.3
77	69.2	33.8
78	70.1	34.2
79	71.0	34.6
80	71.9	35.1
81	72.8	35.5
82	73.7	35.9
83	74.6	36.4
84	75.5	36.8
85	76.4	37.2
86	77.3	37.7
87	78.2	38.1
88	79.1	38.5
89	80.0	39.0
90	80.9	39.4
91	81.8	39.9
92	82.7	40.3
93	83.6	40.7
94	84.5	41.2
95	85.4	41.6
96	86.3	42.1
97	87.2	42.5
98	88.1	42.9
99	89.0	43.4
100	89.9	43.8
200	179.8	87.7
300	269.6	131.5

Distances.	27 deg.	63 degr.
	Latitude and Departure.	
1	9	5
2	1.8	9
3	2.7	1.4
4	3.6	1.8
5	4.5	2.3
6	5.3	2.7
7	6.2	3.2
8	7.1	3.6
9	8.0	4.1
10	8.9	4.5
11	9.8	5.0
12	10.7	5.4
13	11.6	5.9
14	12.5	6.3
15	13.4	6.8
16	14.3	7.2
17	15.1	7.7
18	16.0	8.2
19	16.9	8.6
20	17.8	9.1
21	18.7	9.5
22	19.6	10.0
23	20.5	10.4
24	21.4	10.9
25	22.3	11.3
26	23.2	11.8
27	24.1	12.2
28	24.9	12.7
29	25.8	13.2
30	26.7	13.6
31	27.6	14.1
32	28.5	14.5
33	29.4	15.0
34	30.3	15.4

Distances.	27 deg.	63 degr.
	Latitude and Departure.	
35	31.2	15.9
36	32.1	16.3
37	33.0	16.8
38	33.8	17.2
39	34.7	17.7
40	35.6	18.2
41	36.5	18.6
42	37.4	19.1
43	38.3	19.5
44	39.1	20.0
45	40.1	20.4
46	41.0	20.9
47	41.9	21.3
48	42.8	21.8
49	43.6	22.2
50	44.5	22.7
51	45.4	23.2
52	46.3	23.6
53	47.2	24.1
54	48.1	24.5
55	49.0	25.0
56	49.9	25.4
57	50.8	25.9
58	51.7	26.3
59	52.6	26.8
60	53.5	27.2
61	54.3	27.7
62	55.2	28.2
63	56.1	28.6
64	57.0	29.1
65	57.9	29.5
66	58.8	30.0
67	59.7	30.4
68	60.6	30.9

Distances.	27 deg.	63 deg.
	Latitude and Departure.	
69	61.5	31.3
70	62.4	31.8
71	63.3	32.2
72	64.1	32.7
73	65.0	33.2
74	65.9	33.6
75	66.8	34.1
76	67.7	34.5
77	68.6	35.0
78	69.5	35.4
79	70.4	35.9
80	71.3	36.3
81	72.2	36.8
82	73.1	37.2
83	74.9	37.7
84	74.8	38.1
85	75.7	38.6
86	76.6	39.0
87	77.5	39.5
88	78.4	40.0
89	79.3	40.4
90	80.2	40.9
91	81.1	41.3
92	82.0	41.8
93	82.9	42.2
94	83.7	42.7
95	84.6	43.1
96	85.5	43.6
97	86.4	44.0
98	87.3	44.5
99	88.2	44.9
100	89.1	45.4
200	178.2	60.9
300	267.3	136.3

Distances.	28 deg.	62 degr.
	Latitude and Departure.	
1	9	5
2	1.8	9
3	2.6	1.4
4	3.5	1.9
5	4.4	2.3
6	5.3	2.8
7	6.2	3.3
8	7.1	3.7
9	7.9	4.2
10	8.8	4.7
11	9.7	5.2
12	10.6	5.6
13	11.5	6.1
14	12.4	6.6
15	13.2	7.0
16	14.1	7.5
17	15.0	8.0
18	15.9	8.4
19	16.8	8.9
20	17.7	9.4
21	18.5	9.9
22	19.4	10.3
23	20.3	10.8
24	21.2	11.3
25	22.1	11.7
26	23.0	12.2
27	23.8	12.7
28	24.7	13.1
29	25.6	13.6
30	26.5	14.1
31	27.4	14.5
32	28.2	15.0
33	29.1	15.5
34	30.0	16.0

Distances.	28 deg.	62 degr.
	Latitude and Departure.	
35	30.9	16.4
36	31.8	16.9
37	32.6	17.4
38	33.5	17.8
39	34.4	18.3
40	35.3	18.8
41	36.2	19.2
42	37.1	19.7
43	38.0	20.2
44	38.8	20.7
45	39.7	21.1
46	40.6	21.6
47	41.5	22.1
48	42.4	22.5
49	43.3	23.0
50	44.1	23.5
51	45.0	23.9
52	45.9	24.4
53	46.8	24.9
54	47.7	25.4
55	48.5	25.8
56	49.4	26.3
57	50.3	26.8
58	51.2	27.2
59	52.1	27.7
60	53.0	28.2
61	53.8	28.6
62	54.7	29.1
63	55.6	29.6
64	56.5	30.0
65	57.4	30.5
66	58.3	31.0
67	59.1	31.5
68	60.0	31.9

Distances.	28 deg.	62 deg.
	Latitude and Departure.	
69	60.9	32.4
70	61.8	32.9
71	62.7	33.3
72	63.6	33.8
73	64.4	34.3
74	65.3	34.7
75	66.2	35.2
76	67.1	35.7
77	68.0	36.1
78	68.9	36.6
79	69.7	37.1
80	70.6	37.6
81	71.5	38.0
82	72.4	38.5
83	73.3	39.0
84	74.2	39.4
85	75.1	39.9
86	75.9	40.4
87	76.8	40.8
88	77.7	41.3
89	78.6	41.8
90	79.5	42.2
91	80.3	42.7
92	81.2	43.2
93	82.1	43.7
94	83.0	44.1
95	83.9	44.6
96	84.8	45.1
97	85.6	45.5
98	86.5	46.0
99	87.4	46.5
100	88.3	46.9
200	176.6	93.9
300	264.9	140.8

Distances.	29 deg.	61 degr.
	Latitude and Departure.	
1	9	5
2	1.7	1.0
3	2.6	1.4
4	3.5	1.9
5	4.4	2.4
6	5.2	2.9
7	6.1	3.4
8	7.0	3.9
9	7.9	4.3
10	8.7	4.8
11	9.6	5.3
12	10.5	5.8
13	11.4	6.3
14	12.2	6.8
15	13.1	7.3
16	14.0	7.7
17	14.9	8.2
18	15.7	8.7
19	16.6	9.2
20	17.5	9.7
21	18.4	10.2
22	19.2	10.7
23	20.1	11.1
24	21.0	11.6
25	21.9	12.1
26	22.7	12.6
27	23.6	13.1
28	24.5	13.6
29	25.4	14.1
30	26.2	14.5
31	27.1	15.0
32	28.0	15.5
33	28.9	16.0
34	29.7	16.5

Distances.	29 deg.	61 degr.
	Latitude and Departure.	
35	30.6	17.0
36	31.5	17.4
37	32.4	17.9
38	33.2	18.4
39	34.1	18.9
40	35.0	19.4
41	35.9	19.9
42	36.7	20.3
43	37.6	20.8
44	38.5	21.3
45	39.4	21.8
46	40.2	22.3
47	41.1	22.8
48	42.0	23.3
49	42.9	23.7
50	43.7	24.2
51	44.6	24.7
52	45.5	25.2
53	46.4	25.7
54	47.2	26.2
55	48.1	26.7
56	49.0	27.1
57	49.9	27.6
58	50.7	28.1
59	51.6	28.6
60	52.5	29.1
61	53.4	29.6
62	54.2	30.0
63	55.1	30.5
64	56.0	31.0
65	56.9	31.5
66	57.7	32.0
67	58.6	32.5
68	59.5	33.0

Distances.	29 deg.	61 deg.
	Latitude and Departure.	
69	60.4	33.4
70	61.2	33.9
71	62.1	34.4
72	63.0	34.9
73	63.8	35.4
74	64.7	35.9
75	65.6	36.3
76	66.5	36.8
77	67.3	37.3
78	68.2	37.8
79	69.1	38.3
80	70.0	38.8
81	70.8	39.3
82	71.7	39.7
83	72.6	40.2
84	73.5	40.7
85	74.3	41.2
86	75.3	41.7
87	76.1	42.2
88	77.0	42.7
89	77.8	43.1
90	78.7	43.6
91	79.6	44.1
92	80.5	44.6
93	81.3	45.1
94	82.2	45.6
95	83.1	46.1
96	84.0	46.5
97	84.8	47.0
98	85.7	47.5
99	86.6	48.0
100	87.5	48.5
200	174.9	97.0
300	262.4	145.5

Distances.	30 deg.	60 degr.
	Latitude and Departure.	
1	9	5
2	1.7	1.0
3	2.6	1.5
4	3.5	2.0
5	4.3	2.5
6	5.2	3.0
7	6.1	3.5
8	6.9	4.0
9	7.8	4.5
10	8.7	5.0
11	9.5	5.5
12	10.4	6.0
13	11.3	6.5
14	12.1	7.0
15	13.0	7.5
16	13.9	8.0
17	14.7	8.5
18	15.6	9.0
19	16.5	9.5
20	17.3	10.0
21	18.2	10.5
22	19.1	11.0
23	19.9	11.5
24	20.8	12.0
25	21.7	12.5
26	22.5	13.0
27	23.4	13.5
28	24.2	14.0
29	25.1	14.5
30	26.0	15 0
31	26.8	15.5
32	27.7	16.0
33	28.6	16.5
34	29.4	17.0

Distances.	30 deg.	60 degr.
	Latitude and Departure.	
35	30.3	17.5
36	31.2	18.0
37	32.0	18.5
38	32.9	19.0
39	33.8	19.5
40	34.6	20.0
41	35.5	20.5
42	36.4	21.0
43	37.2	21.5
44	38.1	22.0
45	39.0	22.5
46	39.8	23.0
47	40.7	23.5
48	41.6	24.0
49	42.4	24.5
50	43.3	25.0
51	44.2	25.5
52	45.0	26.0
53	45.9	26.5
54	46.8	27.0
55	47.6	27.5
56	48.5	28.0
57	49.4	28.5
58	50.2	29.0
59	51.1	29.5
60	52.0	30.0
61	52.8	30.5
62	53.7	31.0
63	54.6	31.5
64	55.4	32.0
65	56.3	32.5
66	57.2	33.0
67	58.0	33.5
68	58.9	34.0

Distances.	30 deg.	60 deg.
	Latitude and Departure.	
69	59.8	34.5
70	60.6	35.0
71	61.5	35.5
72	62.3	36.0
73	63.2	36.5
74	64.1	37.0
75	64.9	37.5
76	65.8	38.0
77	66.7	38.5
78	67.6	39.0
79	68.4	39.5
80	69.3	40.0
81	70.2	40.5
82	71.0	41.0
83	71.9	41.5
84	72.7	42.0
85	73.6	42.5
86	74.5	43.0
87	75.3	43.5
88	76.2	44.0
89	77.1	44.5
90	77.9	45.0
91	78.8	45.5
92	79.7	46.0
93	80.6	46.5
94	81.4	47.0
95	82.3	47.5
96	83.2	48.0
97	84.0	48.5
98	84.9	49.0
99	85.7	49.5
100	86.6	50.0
200	173.2	100.0
300	259.8	150.0

Distances.	31 deg.	59 degr.
	Latitude and Departure.	
1	9	5
2	1.7	1.0
3	2.6	1.5
4	3.4	2.1
5	4.3	2.6
6	5.1	3.1
7	6.0	3.6
8	6.9	4.1
9	7.7	4.6
10	8.6	5.1
11	9.4	5.7
12	10.3	6.2
13	11.1	6.7
14	12.0	7.2
15	12.9	7.7
16	13.7	8.2
17	14.6	8.8
18	15.4	9.3
19	16.3	9.8
20	17.1	10.3
21	18.0	10.8
22	18.9	11.3
23	19.7	11.8
24	20.6	12.4
25	21.4	12.9
26	22.3	13.4
27	23.1	13.9
28	24.0	14.4
29	24.9	14.9
30	25.7	15.4
31	26.6	16.0
32	27.4	16.5
33	28.3	17.0
34	29.2	17.5

Distances.	31 deg.	59 degr.
	Latitude and Departure.	
35	30.0	18.0
36	30.9	18.5
37	31.7	19.1
38	32.6	19.6
39	33.4	20.1
40	34.3	20.6
41	35.1	21.1
42	36.0	21.6
43	36.9	22.1
44	37.7	22.7
45	38.6	23.2
46	39.4	23.7
47	40.3	24.2
48	41.1	24.7
49	42.0	25.2
50	42.9	25.7
51	43.7	26.3
52	44.6	26.8
53	45.4	27.3
54	46.3	27.8
55	47.1	28.3
56	48.0	28.8
57	48.9	29.4
58	49.7	29.9
59	50.6	30.4
60	51.4	30.9
61	52.3	31.4
62	53.1	31.9
63	54.0	32.4
64	54.9	33.0
65	55.7	33.5
66	56.6	34.0
67	57.4	34.5
68	58.3	35.0

Distances.	31 deg.	59 deg.
	Latitude and Departure.	
69	59.1	35.5
70	60.0	36.0
71	60.9	36.6
72	61.7	37.1
73	62.6	37.6
74	63.4	38.1
75	64.3	38.6
76	65.1	39.1
77	66.0	39.7
78	66.9	40.2
79	67.7	40.7
80	68.6	41.2
81	69.4	41.7
82	70.3	42.2
83	71.1	42.7
84	72.0	43.3
85	72.9	43.8
86	73.7	44.3
87	74.6	44.8
88	75.4	45.3
89	76.3	45.8
90	77.1	46.3
91	78.0	46.9
92	78.9	47.4
93	79.7	47.9
94	80.6	48.4
95	81.4	48.9
96	82.3	49.4
97	83.1	50.0
98	84.0	50.5
99	84.9	51.0
100	85.7	51.5
200	171.4	103.0
300	257.2	154.5

Distances.	32 deg.	58 degr.
	Latitude and Departure.	
1	8	5
2	1.7	1.1
3	2.5	1.6
4	3.4	2.1
5	4.2	2.6
6	5.1	3.2
7	5.9	3.7
8	6.3	4.2
9	7.6	4.8
10	8.5	5.3
11	9.3	5.8
12	10.2	6.4
13	11.0	6.9
14	11.9	7.4
15	12.7	7.9
16	13.6	8.5
17	14.4	9.0
18	15.3	9.5
19	16.1	10.1
20	17.0	10.6
21	17.8	11.1
22	18.7	11.7
23	19.5	12.2
24	20.4	12.7
25	21.2	13.2
26	22.0	13.8
27	22.9	14.3
28	23.7	14.8
29	24.6	15.3
30	25.4	15.9
31	26.3	16.4
32	27.1	17.0
33	28.0	17.5
34	28.7	18.0
35	29.7	18.5
36	30.5	19.1
37	31.4	19.6
38	32.2	20.1
39	33.1	20.7
40	33.9	21.2
41	34.8	21.7
42	35.6	22.3
43	36.5	22.8
44	37.3	23.3
45	38.2	23.8
46	39.0	24.4
47	39.8	24.9
48	40.7	25.4
49	41.5	26.0
50	42.4	26.5
51	43.2	27.0
52	44.1	27.5
53	44.9	28.1
54	45.8	28.6
55	46.6	29.1
56	47.5	29.7
57	48.3	30.2
58	49.2	30.7
59	50.0	31.3
60	50.9	31.8
61	51.7	32.3
62	52.6	32.9
63	53.4	33.4
64	54.3	33.9
65	55.1	34.4
66	56.0	35.0
67	56.8	35.5
68	58.7	36.0
69	58.5	36.6
70	59.4	37.1
71	60.2	37.6
72	61.0	38.1
73	61.9	38.7
74	62.7	39.2
75	63.6	39.7
76	64.4	40.3
77	65.3	40.8
78	66.1	41.3
79	67.0	41.7
80	67.8	42.4
81	68.7	42.9
82	69.5	43.4
83	70.3	44.0
84	71.2	44.5
85	72.1	45.0
86	72.9	45.6
87	73.8	46.1
88	74.6	46.6
89	75.5	47.2
90	76.3	47.7
91	77.2	48.2
92	78.0	48.7
93	78.8	49.3
94	79.7	49.8
95	80.5	50.3
96	81.4	50.9
97	82.2	51.4
98	83.1	51.9
99	83.9	52.4
100	84.8	53.0
200	169.6	106.0
300	254.4	159.0

Distances.	33 deg.	57 degr.
	Latitude and Departure.	
1	8	5
2	1.7	1.1
3	2.5	1.6
4	3.4	2.2
5	4.2	2.7
6	5.0	3.3
7	5.9	3.8
8	6.7	4.4
9	7.6	4.9
10	8.4	5.4
11	9.2	6.0
12	10.1	6.5
13	10.9	7.1
14	11.7	7.6
15	12.6	8.2
16	13.4	8.7
17	14.3	9.3
18	15.1	9.8
19	15.9	10.4
20	16.8	10.9
21	17.6	11.4
22	18.5	12.0
23	19.3	12.5
24	20.1	13.1
25	21.0	13.6
26	21.8	14.2
27	22.7	14.7
28	23.5	15.3
29	24.3	15.8
30	25.2	16.3
31	26.0	16.9
32	26.9	17.4
33	27.7	18.0
34	28.5	18.5

Distances.	33 deg.	57 degr.
	Latitude and Departure.	
35	29.4	19.1
36	30.2	19.6
37	31.1	20.2
38	31.9	20.7
39	32.7	21.2
40	33.5	21.8
41	34.4	22.3
42	35.2	22.9
43	36.1	23.4
44	36.9	24.0
45	37.7	24.5
46	38.6	25.1
47	39.4	25.6
48	40.3	26.2
49	41.1	26.7
50	41.9	27.2
51	42.8	27.8
52	43.6	28.3
53	44.5	28.8
54	45.3	29.4
55	46.1	30.0
56	47.0	30.5
57	47.8	31.0
58	48.7	31.6
59	49.5	32.1
60	50.3	32.7
61	51.2	33.2
62	52.0	33.8
63	52.9	34.3
64	53.7	34.8
65	54.5	35.4
66	55.4	35.5
67	56.2	36.5
68	57.1	37.0

Distances.	33 deg.	57 deg
	Latitude and Departure.	
69	57.9	37.6
70	58.7	38.1
71	59.6	38.6
72	60.4	39.2
73	61.2	39.7
74	62.1	40.3
75	62.9	40.8
76	63.7	41.4
77	64.6	41.9
78	65.4	42.5
79	66.3	43.0
80	67.1	43.6
81	67.9	44.1
82	68.8	44.6
83	69.6	45.2
84	70.5	45.7
85	71.3	46.2
86	72.1	46.8
87	73.0	47.3
88	73.8	47.9
89	74.7	48.4
90	75.5	49.0
91	76.3	49.5
92	77.2	50.1
93	78.0	50.6
94	78.9	51.2
95	79.7	51.7
96	80.5	52.2
97	81.4	52.8
98	82.2	53.3
99	83.1	53.9
100	83.9	54.5
200	167.7	108.9
300	251.6	163.4

Distances.	34 deg.	56 degr.
	Latitude and Departure.	
1	8	6
2	1.7	1.1
3	2.5	2.7
4	3.3	2.2
5	4.1	2.8
6	5.0	3.4
7	5.8	3.9
8	6.6	4.5
9	7.5	5.0
10	8.3	5.6
11	9.1	6.1
12	9.9	6 7
13	10.8	7.3
14	11.6	7.8
15	12.4	8.4
16	13.3	8.9
17	14.1	9.5
18	14.9	10.1
19	15.8	10.6
20	16.6	11.2
21	17.4	11.7
22	18.2	12.3
23	19.1	12.9
24	19.9	13.4
25	20.7	14.0
26	21.6	14 5
27	22.4	15.1
28	23.2	15.7
29	24.0	16.2
30	24.9	16.8
31	25.7	17.3
32	26.5	17.9
33	27.4	18.4
34	28.2	19.0

Distances.	34 deg.	56 degr.
	Latitude and Departure.	
35	29.0	19.6
36	29.8	20.1
37	30.7	20.7
38	31.5	21.2
39	32.3	21.8
40	33.2	22.4
41	34.0	22.9
42	34.8	23.5
43	35.6	24.0
44	36.5	24.6
45	37.3	25.1
46	38.1	25.7
47	39.0	26.3
48	39.8	26.8
49	40.6	27.4
50	41.4	28.0
51	42.3	28.5
52	43.1	29.1
53	43.9	29.6
54	44.8	30.2
55	45.6	30.7
56	46.4	31.3
57	47.3	31.9
58	48.1	32.4
59	48.9	33.0
60	49.7	33.5
61	50.6	34.1
62	51.4	34.6
63	52.2	35.2
64	53.0	35.8
65	53.9	36.3
66	54.7	36.9
67	55.5	38.4
68	56.4	38.0

Distances.	34 deg.	56 deg.
	Latitude and Departure.	
69	57.2	38.6
70	58.0	39.1
71	58.8	39.7
72	59.7	40.3
73	60.5	40.8
74	61.3	41.4
75	62.2	41.9
76	63.0	42.5
77	63.8	43.1
78	64.7	43.6
79	65.5	44.2
80	66.3	44.7
81	67.1	45.3
82	68.0	45.8
83	68.8	46.4
84	69.6	47.0
85	70.5	47.5
86	71.3	48.1
87	72.1	48.6
88	72.9	49.2
89	73.8	49.8
90	74.6	50.3
91	75.4	50.9
92	76.3	51.4
93	77.1	52.0
94	77.9	52.6
95	78.8	53.1
96	79.6	53.7
97	80.4	54.2
98	81.2	54.8
99	82.1	55.4
100	82.9	55.9
200	165.8	111.8
300	248.7	167.8

Distances.	35 deg.	55 degr.
	Latitude and Departure.	
1	8	6
2	1.7	1.1
3	2.5	1.7
4	3.3	2.3
5	4.1	2.9
6	4.9	3.4
7	5.7	4.0
8	6.6	4.6
9	7.4	5.2
10	8.2	5.7
11	9.0	6.3
12	9.8	6.9
13	10.6	7.5
14	11.5	8.0
15	12.3	8.6
16	13.1	9.2
17	13.9	9.8
18	14.7	10.3
19	15.6	10.9
20	16.4	11.5
21	17.2	12.0
22	18.0	12.6
23	18.8	13.2
24	19.6	13.8
25	20.5	14.3
26	21.3	14.9
27	22.1	15.5
28	22.9	16.1
29	23.7	16.6
30	24.6	17.2
31	25.4	17.8
32	26.2	18.4
33	27.0	18.9
34	27.8	19.5

Distances.	35 deg.	55 degr.
	Latitude and Departure.	
35	28.6	20.1
36	29.5	20.6
37	30.3	21.2
38	31.1	21.8
39	31.9	22.4
40	32.8	22.9
41	33.6	23.5
42	34.4	24.1
43	35.2	24.6
44	36.0	25.2
45	36.8	25.8
46	37.7	26.4
47	38.5	27.0
48	39.3	27.5
49	40.1	28.1
50	41.0	28.7
51	41.8	29.2
52	42.6	29.8
53	43.4	30.4
54	44.2	31.0
55	45.1	31.5
56	45.9	32.1
57	46.7	32.7
58	47.5	33.3
59	48.3	33.8
60	49.1	34.4
61	50.0	35.0
62	50.8	35.6
63	51.6	36.1
64	52.4	36.7
65	53.3	37.3
66	54.1	37.9
67	54.9	38.4
68	55.7	39.0

Distances.	35 deg.	55 deg.
	Latitude and Departure.	
69	56.5	39.6
70	57.3	40.2
71	58.2	40.7
72	59.0	41.3
73	59.8	41.9
74	60.6	42.5
75	61.5	43.0
76	62.3	43.6
77	63.1	44.2
78	63.9	44.8
79	64.7	45.3
80	65.5	45.9
81	66.4	46.5
82	67.2	47.0
83	68.0	47.6
84	68.8	48.2
85	69.6	48.8
86	70.5	49.3
87	71.3	49.9
88	72.1	50.5
89	72.9	51.1
90	73.7	51.6
91	74.6	52.2
92	75.4	52.8
93	76.2	53.4
94	77.0	53.9
95	77.8	54.5
96	78.6	55.1
97	79.5	55.6
98	80.3	56.2
99	81.1	56.8
100	81.9	57.4
200	163.8	114.7
300	245.8	172

Distances.	36 deg.	54 degr.
	Latitude and Departure.	
1	8	6
2	1.6	1.2
3	2.4	1.8
4	3.2	2.3
5	4.0	2.9
6	4.8	3.5
7	5.7	4.1
8	6.5	4.7
9	7.2	5.3
10	8.1	5.9
11	8.9	6.5
12	9.7	7.0
13	10.5	7.6
14	11.3	8.2
15	12.1	8.8
16	12.9	9.4
17	13.8	10.0
18	14.6	10.6
19	15.4	11.2
20	16.2	11.8
21	17.0	12.3
22	17.8	12.9
23	18.6	13.5
24	19.4	14.1
25	20.2	14.7
26	21.0	15.3
27	21.8	15.9
28	22.6	16.4
29	23.5	17.0
30	24.3	17.6
31	25.1	18.2
32	25.9	18.8
33	26.7	19.4
34	27.5	20.0

Distances.	36 deg.	54 degr.
	Latitude and Departure.	
35	28.3	20.6
36	29.1	21.1
37	29.9	21.7
38	30.7	22.3
39	31.5	22.9
40	32.4	23.5
41	33.2	24.1
42	34.0	24.7
43	34.8	25.3
44	35.6	25.8
45	36.4	26.4
46	37.2	27.0
47	38.0	27.6
48	38.8	28.2
49	39.6	28.8
50	40.4	29.4
51	41.3	30.0
52	42.1	30.6
53	42.9	31.1
54	43.7	31.7
55	44.5	32 3
56	45.3	32.9
57	46.1	33.5
58	46.9	34.1
59	47.7	34.7
60	48.5	35.3
61	49.3	35.8
62	50.2	36.4
63	51.0	37.0
64	51.8	37.6
65	52.6	38.2
66	53.4	38.8
67	54.2	39.4
68	55.0	40.0

Distances.	36 deg.	54 deg.
	Latitude and Departure.	
69	55.8	40.6
70	56.6	41.1
71	57.4	41.7
72	58.2	42.3
73	59.0	42.9
74	59.9	43.5
75	60.7	44.2
76	61.5	44.7
77	62.3	45.3
78	63.1	45.8
79	63.9	46.4
80	64.7	47.0
81	65.5	47.6
82	66.3	48.2
83	67.1	48.8
84	68.0	49.4
85	68.8	50.0
86	69.6	50.6
87	70.4	51.1
88	71.2	51.7
89	72.0	52.3
90	72.8	52.9
91	73.6	53.5
92	74.4	54.1
93	75.2	54.7
94	76.0	55.3
95	76.8	55.8
96	77.7	56.4
97	78.5	57.0
98	79.3	57.6
99	80.1	58.2
100	80.9	58.8
00	161.8	117.6
300	242.7	176.3

Distances.	37 deg.	53 degr.
	Latitude and Departure.	
1	8	6
2	1.6	1.2
3	2.4	1.8
4	3.2	2.4
5	4.0	3.0
6	4.8	3.6
7	5.6	4.2
8	6.4	4.8
9	7.2	5.4
10	8.0	6.0
11	8.8	6.6
12	9.6	7.2
13	10.4	7.8
14	11.2	8.4
15	12.0	9.0
16	12.8	9.6
17	13.6	10.2
18	14.4	10.8
19	15.2	11.4
20	16.0	12.0
21	16.8	12.6
22	17.6	13.2
23	18.4	13.8
24	19.2	14.4
25	20.0	15.0
26	20.8	15.6
27	21.6	16.2
28	22.4	16.8
29	23.2	17.4
30	24.0	18.0
31	24.8	18.6
32	25.6	19.2
33	26.4	19.8
34	27.1	20.4
35	27.9	21.0
36	28.7	21.6
37	29.5	22.2
38	30.3	22.8
39	31.1	23.4
40	31.9	24.1
41	32.7	24.7
42	33.5	25.3
43	34.3	25.9
44	35.1	26.5
45	35.9	27.1
46	36.7	27.7
47	37.5	28.3
48	38.3	28.9
49	39.1	29.5
50	39.9	30.1
51	40.7	30.7
52	41.5	31.3
53	42.3	31.9
54	43.1	32.5
55	43.9	33.1
56	44.7	33.7
57	45.5	34.3
58	46.3	34.9
59	47.1	35.5
60	47.9	36.1
61	48.7	36.7
62	49.5	37.3
63	50.3	37.9
64	51.1	38.5
65	51.9	39.1
66	52.7	39.7
67	53.5	40.3
68	54.3	40.9
69	55.1	41.5
70	55.9	42.1
71	56.7	42.7
72	57.5	43.3
73	58.3	43.9
74	59.1	44.5
75	59.9	45.1
76	60.7	45.7
77	61.5	46.3
78	62.3	46.9
79	63.1	47.5
80	63.9	48.1
81	64.7	48.7
82	65.5	49.3
83	66.3	50.0
84	67.1	50.6
85	67.9	51.2
86	68.7	51.8
87	69.5	52.4
88	70.3	53.0
89	71.1	53.6
90	71.9	54.2
91	72.7	54.8
92	73.5	55.4
93	74.3	56.0
94	75.1	56.6
95	75.9	57.2
96	76.7	57.8
97	77.5	58.4
98	78.3	59.0
99	79.1	59.6
100	79.9	60.2
200	159.7	120.4
300	239.6	180.5

Distances.	38 deg.	52 degr.
	Latitude and Departure.	
1	8	6
2	1.6	1.2
3	2.4	1.8
4	3.1	2.5
5	3.9	3.1
6	4.7	3.7
7	5.5	4.3
8	6.3	4.9
9	7.1	5.5
10	7.9	6.2
11	8.7	6.8
12	9.5	7.4
13	10.2	8.0
14	11.0	8.6
15	11.8	9.2
16	12.6	9.9
17	13.4	10.5
18	14.2	11.1
19	15.0	11.7
20	15.8	12.3
21	16.6	12.9
22	17.3	13.6
23	18.1	14.2
24	18.9	14.8
25	19.7	15.4
26	20.5	16.0
27	21.3	16.6
28	22.1	17.2
29	22.9	17.9
30	23.6	18.5
31	24.4	19.1
32	25.2	19.7
33	26.0	20.3
34	26.8	20.5

Distances.	38 deg.	52 degr.
	Latitude and Departure.	
35	27.6	21.6
36	28.4	22.2
37	29.2	22.8
38	29.9	23.4
39	30.7	24.0
40	31.5	24.6
41	32.3	25.2
42	33.1	25.9
43	33.9	26.5
44	34.7	27.1
45	35.5	27.7
46	36.2	28.3
47	37.0	28.9
48	37.8	29.6
49	38.6	30.2
50	39.4	30.8
51	40.2	31.4
52	41.0	32.0
53	41.8	32.6
54	42.6	33.2
55	43.3	33.9
56	44.1	34.5
57	44.9	35.1
58	45.7	35.7
59	46.5	36.3
60	47.3	36.9
61	48.1	37.6
62	48.9	38.2
63	49.6	38.8
64	50.4	39.4
65	51.2	40.0
66	52.0	40.6
67	52.8	41.2
68	53.6	41.9

Distances.	38 deg.	52 deg
	Latitude and Departure.	
69	54.4	42.
70	55.2	43.
71	55.9	43.
72	56.7	44.
73	57.5	45.
74	58.3	45.
75	59.1	46.
76	59.9	46.
77	60.7	47.
78	61.5	48.
79	62.2	48.
80	63.3	49.
81	63.8	49.
82	64.6	50.
83	65.4	51.
84	66.2	51.
85	67.0	52.
86	67.8	53.
87	68.6	53.
88	69.3	54.
89	70.1	54.
90	70.9	55.
91	71.7	56.
92	72.5	56.
93	73.3	57.
94	74.1	57.
95	74.9	58.
96	75.6	59.
97	76.4	59.
98	77.2	60.
99	78.0	61.
100	78.8	61.
200	157.6	123.
300	236.4	184.

Distances.	39 deg.	51 degr.
	Latitude and Departure.	
1	8	6
2	1.6	1.3
3	2.3	1.9
4	3.1	2.5
5	3.9	3.1
6	4.7	3.8
7	5.4	4.4
8	6.2	5.0
9	7.0	5.7
10	7.8	6.3
11	8.5	6.9
12	9.3	7.5
13	10.1	8.2
14	10.9	8.8
15	11.6	9.4
16	12.4	10.1
17	13.2	10.7
18	14.0	11.3
19	14.8	11.9
20	15.5	12.6
21	16.3	13.2
22	17.1	13.8
23	17.9	14.5
24	18.6	15.1
25	19.4	15.7
26	20.2	16.4
27	21.0	17.0
28	21.7	17.6
29	22.5	18.2
30	23.3	18.9
31	24.1	19.5
32	24.9	20.1
33	25.6	20.8
34	26.4	21.4

Distances.	39 deg.	51 degr.
	Latitude and Departure.	
35	27.2	22.0
36	28.0	22.6
37	28.7	23.3
38	29.5	23.9
39	30.3	24.5
40	31.1	25.2
41	31.8	25.8
42	32.6	26.4
43	33.4	27.1
44	34.2	27.7
45	35.0	28.3
46	35.7	28.9
47	36.5	29.6
48	37.3	30.2
49	38.1	30.8
50	38.8	31.5
51	39.6	32.1
52	40.4	32.7
53	41.2	33.4
54	41.9	34.0
55	42.7	34.6
56	43.5	35.2
57	44.3	35.9
58	45.1	36.5
59	45.8	37.1
60	46.6	37.8
61	47.4	38.4
62	48.2	39.0
63	48.9	39.6
64	49.7	40.3
65	50.5	40.9
66	51.3	41.5
67	52.1	42.2
68	52.8	42.8

Distances.	39 deg.	51 deg.
	Latitude and Departure.	
69	53.6	43.4
70	54.4	44.0
71	55.2	44.7
72	55.9	45.3
73	56.7	45.9
74	57.5	46.6
75	58.3	47.2
76	59.1	47.8
77	59.8	48.5
78	60.6	49.1
79	61.4	49.7
80	62.2	50.3
81	62.9	51.0
82	63.7	51.6
83	64.5	52.2
84	65.3	52.9
85	66.1	53.5
86	66.8	54.1
87	67.6	54.7
88	68.4	55.4
89	69.2	56.0
90	69.9	56.6
91	70.7	57.3
92	71.5	57.9
93	72.3	58.5
94	73.1	59.1
95	73.8	59.8
96	74.6	60.4
97	75.4	61.0
98	76.2	61.7
99	76.9	62.3
100	77.7	62.9
200	155.4	125.9
300	233.1	188.8

Distances.	40 deg.	50 degr.
	Latitude and Departure.	
1	.8	.6
2	1.5	1.3
3	2.3	1.9
4	3.1	2.6
5	3.8	3.2
6	4.6	3.8
7	5.4	4.5
8	6.1	5.1
9	6.9	5.8
10	7.7	6.5
11	8.4	7.1
12	9.2	7.7
13	10.0	8.3
14	10.7	9.0
15	11.5	9.6
16	12.3	10.3
17	13.0	10.9
18	13.8	11.6
19	14.6	12.2
20	15.3	12.9
21	16.1	13.5
22	16.9	14.1
23	17.6	14.8
24	18.4	15.4
25	19.2	16.1
26	19.9	16.7
27	20.7	17.3
28	21.4	18.0
29	22.2	18.6
30	23.0	19.3
31	23.7	19.9
32	24.5	20.6
33	25.3	21.2
34	26.0	21.9

Distances.	40 deg.	50 degr.
	Latitude and Departure.	
35	26.8	22.5
36	27.6	23.1
37	28.3	23.8
38	29.1	24.4
39	29.9	25.1
40	30.6	25.7
41	31.4	26.3
42	32.2	27.0
43	32.9	27.6
44	33.7	28.3
45	34.5	28.9
46	35.2	29.6
47	36.0	30.2
48	36.8	30.9
49	37.5	31.5
50	38.3	32.1
51	39.1	32.8
52	39.8	33.4
53	40.6	34.1
54	41.4	34.7
55	42.1	35.3
56	42.9	36.0
57	43.7	36.6
58	44.4	37.3
59	45.2	37.9
60	46.0	38.6
61	46.7	39.2
62	47.5	39.9
63	48.3	40.5
64	49.0	41.1
65	49.8	41.8
66	50.6	42.4
67	51.3	43.1
68	52.1	43.7

Distances.	40 deg.	50 deg.
	Latitude and Departure.	
69	52.9	44.3
70	53.6	45.0
71	54.4	45.6
72	55.2	46.3
73	55.9	46.9
74	56.7	47.6
75	57.4	48.2
76	58.2	48.9
77	59.0	49.5
78	59.7	50.1
79	60.5	50.8
80	61.3	51.4
81	62.0	52.1
82	62.8	52.7
83	63.6	53.3
84	64.3	54.0
85	65.1	54.6
86	65.9	55.3
87	66.6	55.9
88	67.4	56.6
89	68.2	57.2
90	68.9	57.9
91	69.7	58.5
92	70.5	59.1
93	71.2	59.8
94	72.0	60.4
95	72.7	61.1
96	73.5	61.7
97	74.3	62.3
98	75.1	63.0
99	75.8	63.6
100	76.6	64.3
200	153.2	128.6
300	229.8	192.8

Distances.	41 deg.	49 degr.
	Latitude and Departure.	
1	8	7
2	1.5	1.3
3	2.3	2.0
4	3.0	2.6
5	3.8	3.3
6	4.5	3.9
7	5.3	4.6
8	6.0	5.2
9	6.8	5.9
10	7.5	6.6
11	8.3	7.2
12	9.1	7.9
13	9.8	8.5
14	10.6	9.2
15	11.3	9.8
16	12.1	10.5
17	12.8	11.2
18	13.6	11.8
19	14.3	12.5
20	15.1	13.1
21	15.9	13.8
22	16.6	14.4
23	17.4	15.1
24	18.1	15.7
25	18.9	16.4
26	19.6	17.1
27	20.4	17.7
28	21.1	18.4
29	21.9	19.0
30	22.6	19.7
31	23.4	20.3
32	24.1	21.0
33	24.9	21.6
34	25.7	22.3

Distances.	41 deg.	49 degr.
	Latitude and Departure.	
35	26.4	22.9
36	27.2	23.6
37	27.9	24.3
38	28.7	24.9
39	29.4	25.6
40	30.2	26.2
41	30.9	26.9
42	31.7	27.5
43	32.4	28.2
44	33.2	28.9
45	33.9	29.5
46	34.7	30.2
47	35.4	30.8
48	36.2	31.5
49	36.9	32.1
50	37.7	32.8
51	38.5	33.4
52	39.2	34.1
53	40.0	34.8
54	40.7	35.4
55	41.5	36.1
56	42.2	36.7
57	43.0	37.4
58	43.8	30.0
59	44.5	38.7
60	45.3	39.4
61	46.0	40.0
62	46.8	40.7
63	47.5	41.3
64	48.3	42.0
65	49.0	42.6
66	49.8	43.3
67	50.6	43.9
68	51.3	44.6

Distances.	41 deg.	49 deg.
	Latitude and Departure.	
69	52.1	45.2
70	52.8	45.9
71	53.6	46.6
72	54.3	47.2
73	55.1	47.8
74	55.8	48.5
75	56.6	49.2
76	57.4	49.8
77	58.1	50.5
78	58.9	51.2
79	59.6	51.8
80	60.4	52.5
81	61.1	53.1
82	61.9	53.8
83	62.6	54.4
84	63.4	55.1
85	64.1	55.7
86	64.9	56.4
87	65.6	57.1
88	66.4	57.7
89	67.1	58.4
90	67.9	59.0
91	68.7	59.7
92	69.4	60.3
93	70.2	61.0
94	70.9	61.6
95	71.7	62.3
96	72.4	62.9
97	73.2	63.6
98	73.9	64.3
99	74.7	64.9
100	75.5	65.6
200	150.9	131.2
300	226.4	196.8

Distances.	42 deg.	48 degr.
	Latitude and Departure.	
1	0.7	7
2	1.5	1.3
3	2.2	2.0
4	3.0	2.7
5	3.7	3.3
6	4.4	4.0
7	5.2	4.7
8	5.9	5.3
9	6.7	6.0
10	7.4	6.7
11	8.2	7.3
12	8.9	8.0
13	9.7	8.7
14	10.4	9.3
15	11.1	10.0
16	11.9	10.7
17	12.6	11.3
18	13.4	12.0
19	14.1	12.7
20	14.9	13.4
21	15.6	14.0
22	16.3	14.7
23	17.1	15.4
24	17.8	16.0
25	18.6	16.7
26	19.3	17.4
27	20.1	18.0
28	20.8	18.7
29	21.5	19.4
30	22.3	20.1
31	23.0	20.7
32	23.8	21.4
33	24.5	22.1
34	25.3	22.7

Distances.	42 deg.	48 degr.
	Latitude and Departure.	
35	26.0	23.4
36	26.7	24.1
37	27.5	24.7
38	28.2	25.4
39	29.0	26.1
40	29.7	26.8
41	30.4	27.4
42	31.2	28.1
43	31.9	28.7
44	32.7	29.4
45	33.4	30.1
46	34.2	30.8
47	34.9	31.4
48	35.7	32.1
49	36.4	32.8
50	37.2	33.5
51	37.9	34.1
52	38.6	34.8
53	39.4	35.4
54	40.1	36.1
55	40.9	36.8
56	41.6	37.5
57	42.3	38.1
58	43.1	38.8
59	43.8	39.4
60	44.6	40.1
61	45.3	40.8
62	46.1	41.5
63	46.8	42.1
64	47.5	42.8
65	48.3	43.5
66	49.0	44.2
67	49.8	44.8
68	50.5	45.5

Distances.	42 deg.	48 deg.
	Latitude and Departure.	
69	51.3	46.2
70	52.0	46.8
71	52.7	47.5
72	53.5	48.2
73	54.2	48.8
74	55.0	49.5
75	55.7	50.2
76	56.4	50.9
77	57.2	51.5
78	57.9	52.2
79	58.7	52.9
80	59.4	53.5
81	60.2	54.2
82	60.9	54.9
83	61.7	55.5
84	62.4	56.2
85	63.2	56.9
86	63.9	57.5
87	64.7	58.2
88	65.4	58.9
89	66.1	59.5
90	66.9	60.2
91	67.6	60.9
92	68.4	61.5
93	69.1	62.2
94	69.9	62.9
95	70.6	63.5
96	71.3	64.2
97	72.1	64.9
98	72.8	65.5
99	73.6	66.2
100	74.3	66.9
200	148.6	133.8
300	222.9	200.7

Distances.	43 deg.	47 degr.
	Latitude and Departure.	
1	7	7
2	1.5	1.4
3	2.2	2.0
4	2.9	2.7
5	3.6	3.4
6	4.4	4.1
7	5.1	4.8
8	5.8	5.4
9	6.6	6.1
10	7.3	6.8
11	8.0	7.5
12	8.8	8.2
13	9.5	8.9
14	10.2	9.5
15	11.0	10.2
16	11.7	10.9
17	12.4	11.6
18	13.2	12.3
19	13.9	13.0
20	14.6	13.6
21	15.3	14.3
22	16.1	15.0
23	16.8	15.7
24	17.5	16.4
25	18.3	17.0
26	18.9	17.7
27	19.7	18.4
28	20.5	19.1
29	21.2	19.8
30	21.9	20.5
31	22.7	21.1
32	23.4	21.8
33	24.1	22.5
34	24.8	23.2

Distances.	43 deg.	47 degr.
	Latitude and Departure.	
35	25.6	23.9
36	26.3	24.5
37	27.0	25.2
38	27.8	25.9
39	28.5	26.6
40	29.2	27.3
41	30.0	28.0
42	30.7	28.6
43	31.4	29.3
44	32.2	30.0
45	32.9	30.7
46	33.6	31.4
47	34.4	32.0
48	35.1	32.7
49	35.8	33.4
50	36.6	34.1
51	37.3	34.8
52	38.0	35.5
53	38.8	36.1
54	39.5	36.8
55	40.2	37.5
56	40.9	38.2
57	41.7	38.9
58	42.4	39.5
59	43.1	40.2
60	43.9	40.9
61	44.6	41.6
62	45.3	42.3
63	46.1	43.0
64	46.8	43.6
65	47.5	44.3
66	48.3	45.0
67	49.0	45.7
68	49.7	46.4

Distances.	43 deg.	47 deg.
	Latitude and Departure.	
69	50.5	47.0
70	51.2	47.7
71	51.9	48.4
72	52.6	49.1
73	53.4	49.8
74	54.1	50.5
75	54.8	51.1
76	55.6	51.8
77	56.3	52.5
78	57.0	53.2
79	57.8	53.9
80	58.5	54.5
81	59.2	55.2
82	60.0	55.9
83	60.7	56.6
84	61.4	57.3
85	62.2	58.0
86	62.9	58.7
87	63.6	59.3
88	64.3	60.0
89	65.1	60.7
90	65.8	61.4
91	66.5	62.1
92	67.3	62.7
93	68.0	63.4
94	68.7	64.1
95	69.5	64.8
96	70.2	65.5
97	70.9	66.1
98	71.7	66.8
99	72.4	67.5
100	73.1	68.2
200	146.3	136.4
300	219.4	204.6

Distances.	44 deg.	46 degr.
	Latitude and Departure.	
1	7	7
2	1.4	1.4
3	2.2	2.1
4	2.9	2.8
5	3.6	3.5
6	4.3	4.2
7	5.0	4.9
8	5.8	5.6
9	6.5	6.2
10	7.2	6.9
11	7.9	7.6
12	8.6	8.3
13	9.3	9.0
14	10.1	9.7
15	10.8	10.4
16	11.5	11.1
17	12.2	11.8
18	12.9	12.5
19	13.7	13.2
20	14.4	13.9
21	15.1	14.6
22	15.8	15.3
23	16.5	16.0
24	17.3	16.7
25	18.0	17.4
26	18.7	18.1
27	19.4	18.8
28	20.1	19.5
29	20.9	20.1
30	21.6	20.8
31	22.3	21.5
32	23.0	22.2
33	23.7	22.9
34	24.5	23.6

Distances.	44 deg.	46 degr.
	Latitude and Departure.	
35	25.2	24.3
36	25.9	25.0
37	26.6	25.7
38	27.3	26.4
39	28.0	27.1
40	28.8	27.8
41	29.5	28.5
42	30.2	29.2
43	30.9	29.9
44	31.6	30.6
45	32.4	31.3
46	33.1	32.0
47	33.8	32.7
48	34.5	33.4
49	35.2	34.0
50	36.0	34.7
51	36.7	35.4
52	37.4	36.1
53	38.1	36.8
54	38.8	37.5
55	39.6	38.2
56	40.3	38.9
57	41.0	39.6
58	41.7	40.3
59	42.4	41.0
60	43.2	41.7
61	43.9	42.4
62	44.6	43.1
63	45.3	43.8
64	46.0	44.5
65	46.8	45.8
66	47.5	45.5
67	48.2	46.2
68	48.9	47.9

Distances.	44 deg.	46 deg.
	Latitude and Departure.	
69	49.6	47.9
70	50.3	48.6
71	51.1	49.3
72	51.8	50.0
73	52.5	50.7
74	53.2	51.4
75	53.9	52.1
76	54.7	52.8
77	55.4	53.5
78	56.1	54.2
79	56.8	54.9
80	57.5	55.6
81	58.3	56.3
82	59.0	57.0
83	59.7	57.7
84	60.4	58.4
85	61.1	59.0
86	61.9	59.7
87	62.6	60.4
88	63.3	61.1
89	64.0	61.8
90	64.7	62.5
91	65.5	63.2
92	66.2	63.9
93	66.9	64.6
94	67.6	65.3
95	68.3	66.0
96	69.0	66.7
97	69.8	67.4
98	70.5	68.1
99	71.2	68.8
100	71.9	69.5
200	143.9	138.9
300	215.8	208.4

Distances.	45 deg.	45 degr.
	Latitude and Departure.	
1	7	7
2	1.4	1.4
3	2.1	2.1
4	2.8	2.8
5	3.5	3.5
6	4.2	4.2
7	4.9	4.9
8	5.6	5.6
9	6.4	6.4
10	7.1	7.1
11	7.8	7.8
12	8.5	8.5
13	9.2	9.2
14	9.9	9.9
15	10.6	10.6
16	11.3	11.3
17	12.0	12.0
18	12.7	12.7
19	13.4	13.4
20	14.1	14.1
21	14.8	14.8
22	15.5	15.5
23	16.3	16.3
24	17.0	17.0
25	17.7	17.7
26	18.4	18.4
27	19.1	19.1
28	19.8	19.8
29	20.5	20.5
30	21.2	21.2
31	21.9	21.9
32	22.6	22.6
33	23.3	23.3
34	24.0	24.4
35	24.7	24.7
36	25.4	25.4
37	26.1	26.1
38	26.8	26.8
39	27.5	27.5
40	28.3	28.3
41	29.0	29.0
42	29.7	29.7
43	30.4	30.4
44	31.1	31.1
45	31.8	31.8
46	32.5	32.5
47	33.2	33.2
48	33.9	33.9
49	34.6	34.6
50	35.3	35.3
51	36.0	36.0
52	36.7	36.7
53	37.5	37.5
54	38.2	38.2
55	38.9	38.9
56	39.6	39.6
57	40.3	40.3
58	41.0	41.0
59	41.7	41.7
60	42.4	42.4
61	43.1	43.1
62	43.8	43.8
63	44.5	44.5
64	45.2	45.2
65	45.9	45.9
66	46.6	46.6
67	47.4	47.4
68	48.1	48.1
69	48.8	48.8
70	49.5	49.5
71	50.2	50.2
72	50.9	50.9
73	51.6	51.6
74	52.3	52.3
75	53.0	53.0
76	53.7	53.7
77	54.4	54.4
78	55.1	55.1
79	55.8	55.8
80	56.6	56.6
81	57.3	57.3
82	58.0	58.0
83	58.7	58.7
84	59.4	59.4
85	60.1	60.1
86	60.8	60.8
87	61.5	61.5
88	62.2	62.2
89	62.9	62.9
90	63.6	63.6
91	64.3	64.3
92	65.0	65.0
93	65.7	65.7
94	66.5	66.5
95	67.2	67.2
96	67.8	67.8
97	68.6	68.6
98	69.3	69.3
99	70.0	70.0
100	70.7	70.7
200	111.4	111.4
300	212.1	212.1

CHAP. XIII.

The Use of the Tables in Plain Sailing.

THese Tables (as I said before) Mr. *Colsome* hath been pleased to place in his Book called his *New Kalendar*, and both there, and of late in my Fathers *Seamans Practice*, they be printed with *Complements* below, which my Father (were he alive) would be ashamed to see: for without that, 'tis far easier to know the *Southing* or *Northing*, from the *Easting* or *Westing*, by the *Course* from the *South* or *North*, *East* or *West*; for let the Course be what it will, from the *North* or *South*, under that is the *difference of Latitude* in the Colume against the distance run; and let the *Course* be what it will from the *East* or *West*, under that in the Colume against the *distance run*, is the *Easting* or *Westing*: As, suppose the Course be *South*, 40 degrees *Westerly*, against the *distance run*, and under 40 degrees, is the *difference of Latitude*, and against that, in the next Colume, is the *Meridian distance*, and the *Course* from the *East* or *West* is 50 *deg.* over that Colume, (as you may see in the Tables.)

How to keep a Reckoning by the Tables.

Suppose upon the 10th *of* June 1683, *being* Friday, *I departed from a certain place that lieth in* 32 deg. 20′ (*of* North Latitude) *and sailed as followeth.*

Day		Course.	Miles.	North.	West.
June 10					
11	*Saturday*	N W by N	90	74 6	50 3
12	*Sunday*	N W	100	70 7	70 7
13	*Monday*	N E	89	62 3	62 3
14	*Tuesday*	N W	100	70 7 05 6	70 7 05 6
15	*Wednesday*	W N W	100	37 5	32 7
16	*Thursday*	West	100	00 0	100 0
17	*Friday*	West	78	00 0	78 0

For

For the working this, I look in the Tables (before ſet down) and conſider the Courſe is 34 *deg.* neareſt (look for 34 *deg.*) and againſt the diſtance run, the firſt day 90 miles, in the Colume under 34 *deg.* I find 74 6, that is, 74 miles 6 tenths; which is my *Northing* made that 24 hours, becauſe it's under the Courſe ſailed from the *North:* In the next colume, and under 56 *deg.* I find 50 miles 3 tenths for my *Weſting*, becauſe 'tis under my Courſe from the *Weſt:* Set it down (as you ſee againſt *Saturday*) and when 'tis in that order, I have my Columes ruled (as here following you ſee) for my Reckoning; and ſet down the 11th *Saturday.* Before you proceed farther, conſider what you muſt do with your *difference of Latitude:* Now becauſe I am in a *North Latitude* and have gone to the *Northwards*, therefore this 74 miles 6 tenths, or 75 miles, (for 6 tenths is above half a mile) muſt be converted into degrees and minutes, by dividing of it by 60, and it is 1 *deg.* 15′: that adde to the *Latitude* I departed from yeſterday, *viz.* 32 *deg.* 20′, and it makes 33 *deg.* 35′ (the *Latitude* I am in to day); ſet it down in your Reckoning againſt Saturday, and in the next Colume beyond it ſet the Meridian-diſtance 50 miles, and ſo the firſt Line of the Reckoning will be read thus: *The* 11th *day being* Saturday, *I was in the Latitude of* 33 deg. 35′, *and had Weſt Meridian-diſtance* 50 *miles.* And this is the meaning of the firſt days *Reckoning.*

The next day being *Sunday*, I work the Courſe and diſtance given, as before is ſet down; and when I have added my Northing, as before, I ſet it down as you ſee in the following *Reckoning*; but my Meridian-diſtance being Weſting, I adde it to the Weſting yeſterday, and it makes my whole Weſting to this time:

That yeſterday was	050 miles.
That to day is	071 miles.
The whole is	121

Set down 121 miles in the Reckoning, and it ſtands as in the ſecond Line of the *Reckoning.* And doing thus daily, you have your whole *Meridian-diſtance* for any day of your *Reckoning* given, by adding two numbers together.

If it fall out, through contrary winds, that you make *Eaſting* when you would make *Weſting*, (or the contrary, as in the third days work) *ſubſtract* your *Eaſting* ſo made, from your *Weſting*, and the remainder will be your whole *Weſting:* The like is to be underſtood of the reſt. And this is a true way of keeping a *Reckoning* by *Plain Sailing.* Now if you demand how you ſhall do at any time to know the baring and diſtance

distance from the place you set, I answer, you have your whole *Meridian-distance*, the *Latitude* you are in, and the *Latitude* you set from, to find the *Course* and distance; and if you will, you may make a *Column* for the whole *difference of Latitude*, and carry it along as you do the whole *Meridian-distance*; but I think it needless, because it is but substracting the lesser *Latitude* from the *greater*, and converting that into *miles*, and you have the same thing.

These plain Reckonings doth well enough to and from places near the *Equinoctial*, or to any places that you come *back* near the same way you *went out*, but in other *runs* not: For the World is round, and Parallels as they come nearer the *Poles*, are *lesser* than *great Circles*; so that if a man be bound from *London* to the *West Indies*, it may happen that Westerly winds may carry him so to the Southwards, that he may make but little *Meridian-distance* till he comes as far *Southerly* as 25 degrees; and when he comes home, he may be set to the *Northwards* by Easterly winds, so that he may make but little *Meridian-distance*, till he comes so far to the Northwards as 35 degrees, or sometimes 45 degrees. Now no plain Reckoning will come near the truth in this case; but some other way that will measure the World, (which is a Globious Raddy.) However, this as I say, doth well in many cases. The Reckoning is this following; which I call, An Account of the *Northing* and *Southing*, *Easting* and *Westing*, that we made in our *Voyage* from *Bermuda* to the Capes of *Virienia*, namely, *Cape Henry*, and commonly over the head of the *Reckoning*, right to some such purpose, as I have done here.

From

From Bermuda *we departed the* 10th *day of* June 1683, *being* Friday, *and were bound to Cape* Henry *in* Virienia, *which (as it is generally accounted) hath* Weſt Meridian-diſtance *from that Iſland* 420 *miles, and lieth in* North Latitude 37 deg. *Here followeth my Account of* Northing *and* Southing, Eaſting *and* Weſting *that* Voyage.

Days Mon.	Week-days.	Latitude deg.	Latitude mi.	Merid. diſtan. Weſt. miles.	Things of note in the Voyage.
11	*Saturday* ob.	33	35	050	Fair weather, the wind W S W.
12	*Sunday* obſerv.	34	46	121	A hard Gale at N W by N.
13	*Monday* obſer.	35	49	058	A freſh gale N W by N. we ſee a Ship.
14	*Tueſday* obſer.	36	05	134	Fair weather, the wind S W.
15	*Wedneſday* ob.	36	43	226	A fair Southerly wind, but variable.
16	*Thurſday* ob.	36	43	326	The wind at Eaſt, fair weather.
17	*Friday* obſerv.	36	46	404	The wind at Eaſt, and fair weather.
And we ſee Cape *Henry* and ſet it, and it bore off us North North Weſt, and was diſtance by eſtimation, five leagues.					

THus you may keep a Reckoning of the *Meridian-diſtance*, and the *Northing* and *Southing* of a Ship, any where, which I call *Plain Sailing*: but (as I ſaid before) 'tis not ſufficient to know, and do this, but we muſt think of ſome other way to keep an account of the *Longitude* made in any *Parallel*; which we will do, by turning the miles of *Meridian-diſtance* into degrees and minutes (every day) and ſo ſetting it down in a *Colume* (for that purpoſe) added to this; and this is properly called *Mercator's Sailing*, becauſe he ſhewed the firſt deſcription of this way: and indeed that is the onely way to keep all Reckonings at Sea, except a *coaſting* or *ſhort run*, or other *runs* that a man comes the ſame way *home* that he *went out* (or near it); and in ſuch caſes, the above-mentioned *Reckoning* is exact enough. But for the doing hereof, it is neceſſary that you have ſomething that will ſhew you *how many miles makes a degree of Longitude, in any Latitude*; and there is ſuch a Line called the *Line of Longitudes*, deſcribed upon the *Plain Scale*, with the manner of its Projection, in Chap. III. Fig. III. The Uſe of which Scale I ſhall here ſhew you.

CHAP. XIV.

Of Mercator's *Sailing: And how to keep a Reckoning, according to* Mercator's *Projection, by the Plain Scale.*

ADmit I have the ſame *Reckoning* to keep that I had before, ſet down the firſt days work, as I have there done, and the *Meridian-diſtance* that I had the firſt day, convert into *degrees* and *minutes* in thoſe Parallels by the Scale of Longitude, thus: See what the *middle Latitude* that you ſailed through between yeſterday and to day was, by adding them both together, and taking the half, and I find it was 32 *deg.* 57′. Fix your Compaſſes upon the Line of *Chords*, and take off that *middle Latitude*; that done, carry it to the Line of *Longitude*, fixing one foot in 60, and where the other foot falls, it gives the number of *miles* that makes a *degree* in that *Latitude*, which here in this caſe I find to be 50 miles to a degree; from which I conclude, that this 24 hours I have ſailed a degree of Longitude. Set it down in a Colume which you muſt make on purpoſe for it, next to the Meridian-diſtance, as in the Reckoning following; and it is *Weſting*, becauſe the *Meridian-diſtance* is *Weſting*.

Then for the ſecond days work, Take the *middle Latitude* between the firſt days work and the ſecond, which is done by taking half the difference of Latitude between yeſterday and to day (it was the half of 71 miles) and adde it to the Latitude yeſterday (becauſe you increaſe your Latitude) and it makes the *middle Latitude* 33 *deg.* 22′. Note, *That if your* Latitude *had decreaſed, you muſt have* ſubtracted *it*: but your own reaſon will give you that. This *middle Latitude* take out of your Line of Chords (as before) and apply it to the Line of *Longitude* from 60, and the other foot will give 50 (neareſt) which is the number of miles that makes a degree in that Latitude. Now, becauſe the *Meridian-diſtance* is more miles than makes a degree, divide the Meridian-diſtance by 50, and the *Quotient* is 1 *deg.* the remainder is 21. Say then (by the *Rule of Three*) if 50 miles gives 60 minutes, what ſhall 21 give? and I find it gives 25 minutes $\frac{10}{50}$ or $\frac{1}{5}$ of a minute (which fraction) I regard not: ſo that to conclude, I find this 71 miles of *Meridian-*

dian-distance is 1 *deg.* 25′ : I adde this to my Longitude yesterday, which was 1 *deg.* and it makes 2 *deg.* 25′. Set it down as you see in your Reckoning. In this manner you must set down the whole *Meridian-distance*, and *difference* of *Longitude* in the last Colume ; so that no man can take you unprovided of giving him an account where you are, or where you were any day since you set out.

Note, That if you be shortned by contrary winds, that you make *Easting* when you would make *Westing* (or the contrary) so that you make your *Longitude* less ; then *substract* it : but surely your own reason will suggest that. This may satisfie for Examples of this nature : The like is to be understood of any other.

Here followeth the *Reckoning* which should be writ over the head or top of it, as the other is, or to that purpose ; which I omit for brevity sake.

The foregoing Reckoning according to Mercator.

Days Mon.	Week-days.	Latit. d.	Latit. m.	Merid. distan. West. miles.	Long. East. in d.	Long. East. in m.	Things remarkable in the Voyage.
11	*Saturd.* ob.	33	35	0050	01	00	Fair weather, the wind W S W.
12	*Sunday* ob.	34	46	0121	02	25	A hard Gale at N W by N.
13	*Mund.* ob.	35	49	0058	00	56	A hard Gale at N W by N.
14	*Tuesd.* ob.	36	05	0134	02	21	A fair day, the wind Southerly.
15	*Wednes.* ob.	36	43	0226	04	16	The wind East, and fair weather.
16	*Thursd.* ob.	36	43	0326	06	20	The wind S E, and fair weather.
17	*Friday* ob.	36	46	0404	07	58	South East, and fair weather.
							And we see Cape *Henry*, and it bore N N W, and by estimation it was five leagues off.

AND thus the *Plain Scale* will work the best way of Sailing to a minute of a degree, and less (if need required it). I call this of *Mercator*'s *Sailing* the best way of sailing, because 'tis most in use ; and *Great Circle Sailing*, the neareſt way of sailing, but cannot be used so much as this, because the Land hinders you in most Voyages from following that Arch that would lead you the neareſt way. I would have all men prize the *Plain Scale* : I am afraid there be many men that work by *Gunter*, and the *Tables of Logarithms*, and the *Square* and *Cube*, that do not know the true use of this *Scale*, but despise it, and know

not what they do in thoſe deeper things, for want of knowing this well. (This as a Caution by the way.)

I do not know any better way of keeping a *Reckoning* than this; but it will be ſomething abreviated, when you come to work it by the Complement of the Latitude, in proportion with Radins. But I ſhall come to that in order.

But again, by this Plain Scale.

WHen you have found how many *miles* makes a *degree* in the *middle Latitude*, your beſt way is to work your *Meridian-diſtance*, thus: Say (by the Rule of Three) If ſo many miles (admit it were 49) gives 60′, what ſhall your *Meridian-diſtance* in miles give? what comes out, is leagues of Longitude; that divided by 60 (if the number be above 60) is degrees, and the remainder minutes of Longitude; if leſs than 60, they be minutes.

CHAP. XV.

The Deſcription or Projection of the Plain Sea-Chard, *or any plain* Plat *or* Draft.

FOr Coaſting, the onely thing is ſuch Chards or Plats that have a large Scale, and ſo the true diſtances and Courſes from place to place will be the more exact, and the dangers the more perſpicuous. The manner of making theſe Drafts, is on this wiſe.

Suppoſe I have a Skin or clean Skins upon a Board (which may be reſembled by this following) and have a mind to make ſuch a Draft as this is here, by another of the ſame Scale: I'll take off the Land from the other with oyled Papers fitted for that purpoſe, and having ſome North and South, Eaſt and Weſt Lines drawn here in this, as is in that, I'll lay them Papers with the Land taken off in them by the ſame Lines here as I did there, and with a Penſil of braſs I'll run the Land over, and it will leave the impreſſion of the ſame on the clean Plat, that draw out (as here); this done, from one Center (as here upon ⊙) deſcribe a Circle with as large a Semi-diameter as the Board or Plat will bear, and divide it into four equal parts, for the North, South, East,

N

37 36 35 34 33 32 31 30 29

W E S

C F B D A K L

Against Page 101.

East, and West points of your Draft, and draw them, as here N ⊙ S and W ⊙ E. (*Note*, They must be parallel Lines to them East and West, North and South Lines, which are drawn before you laid down the Land.) This done, divide your Circle into sixteen equal parts; and from them parts draw from one of them, through every one of them, a Line from side to side of the Draft, and it will make 30 points at the Center, besides the Meridian it self: And because there are 15 such points, every one will be two points for a North by West Line, drawn through must be from that Center a South by East Line also; and so of the rest. As for the Line or two points which be wanting, in the next Center you will have one run by it; so that from your first Center 'tis but drawing a Line parallel to it, and you have 32 points: and thus do by the rest. If you will, you may make but eight Centers, unless it be in a large Draft. I divided the first Circle here into 32 points, but 16 is the number that is used for these Centers; and therefore draw no more till your other Lines be all drawn, for fear of mistaking.

CHAP. XVI.

The Use of the Plain Sea-Chard.

THE Use of this Draft is very easie and common, so that 'tis but superfluous to speak of it. However, I'll shew it here. If you would find how one Land bears from another, see what point runs neareſt from one Land to the other; and if it be not exact, take half between that and the next point, or a quarter, and run it along, and mind what point it is neareſt to, and which way your Fraction is from that point, and so count their bearing.

EXAMPLE.

I would know how the Northermost part of the Island at A bears from B. I fix my Compasses at B, and looking, I see the Line C B run something near it; but taking my Compasses, and from B sweeping that Line, I carry it along and find it bears some of the Island to the Northwards, and but a little; so that I guess the Course will be something more Westerly than that Line (which is South West by West)

and

and therefore will count it South West by West ¼ Westerly. The like of any other.

Secondly, if you would set off any distance sailed upon any Course, take the distance from the Head Land or place to the point of the Compass that you sailed on, just sweeping it, and carry it along a good way from thence in that point; then lay your Scale from the place you would set off from, so as the Compasses may just sweep the Scale, and take your distance that you would set off, and set it from the place by the edge of your Scale, and there is your Ship or the place you desire, because the edge of your Scale is parallel to the Line or Point of the Compass you would set off.

Thirdly, If you would know the Meridian-distance between two places, then take the neareſt distance between the place and the next Meridian-line that runs between them, and carry that by that Line, till you come to have the other place East or West off you, according as it falls; and that done, continuing that foot which you run from the Land in that place it falls to be, extend the other to the Head Land or place appointed, and that apply to your Scale, or graduated Meridian, and it gives you the miles or leagues of Meridian-distance required.

EXAMPLE.

Admit I would know the Meridian distance between A and B, the neareſt Meridian-line to A is E; I'll sweep that Line from A, and carry it in the same Line with that extent from the Line Westerly, as I took it, till I come to F; and then from that distance West there I'll extend my Compasses to B, and apply it to my graduated Meridian, and it makes 37 leagues upon the Meridian, or 1 *deg.* 51′.

If you would find the difference of Latitude between two places, do the same from East and West Lines, as you did here from a North and South Line.

Lastly, if you would find the Latitude of any place, take the neareſt distance between that place and the next East and West Line between them, and run it along that Line till you come to the graduated Meridian, (keeping the foot of your Compasses that you run from the place the same way) and it will cut the Meridian-line in that Latitude which the place lies in you desire.

EXAM-

EXAMPLE.

If I would know what Latitude the point A lies in, I fix my Compasses in A, and sweep the Line O, and run it to the Meridian-line, and it falls at K, which is 32 degrees, the places Latitude required. The like of any other.

CHAP. XVII.

The Description, Projection, and Use of such Instruments *as at Sea are fittest for* Observation *for finding of the Latitude.*

I. *The Projection of the Sea-Quadrant.*

Fig. I. THis Quadrant consists of no more but 90 degrees, or a quarter of a Circle: in the great Arch E F is 30 degrees, and in the little Arch S T is 60 degrees, cut off upon these Arches, from the Arch of 90 degrees D C B (the Arch D C being equal to E F, and C B equal to T S, and all of them described from that center where the Horizon Vain stands, which is at A): so that for the making of it, 'tis but laying down the 90 degrees of the Quadrant D A B, and from it project your Quadrant at what dimention you please; but commonly the semi-diameter of the little Arch (which is A S) is one third of the semi-diameter of the great Arch A F or A E.

Now to observe with this Instrument.

THere are three Vains, as R K A: That at R is the *Sight-Vain*, that at K is the *Shade-Vain*, and that at A the *Horizon-Vain*. The *Horizon-Vain* is set home to the center of the Quadrant, (as you may see at A); the *Shade-Vain* is always set on the 60th Arch at any fifth degree, as at 5 degrees, 10 degrees, *&c.* and there remains without alteration; the *Sight-Vain* is always set on the 30th Arch, and is to be removed as the Sun riseth. There is a little hole in the *Sight-Vain*, through which you look upon a Line that is in the *Horizon-Vain* from

from the upper ſide of a ſlit there, through which you ſee the Horizon; and this *Vain* is to be removed ſo as to ſee the *Horizon*, the ſhade of the *Shade-Vain*, and the Line on the upper edge of the *Horizon-Vain*, all in one exactly, and then it is right ſet; and as the Sun riſeth it will require to have the *Sight-Vain* removed lower (which do) ſtill till the Sun be up or upon the Meridian that day; and then you will find it will require to be removed back again: by which you know the Sun is upon the Meridian; therefore let all ſtand till you ſee it doth ſo, and ſee what you have upon your Quadrant, thus.

Count from the *Sight-Vain* K how many deg. there is to E, and alſo what number of degrees and minutes there is on the great Arch from R to E, and adde them together, that ſum is the *Complement of the Suns Meridian Altitude* for that day; which work as I ſhall ſhew (in Rules for that purpoſe) to find the Latitude. This Inſtrument is the beſt that I know, to obſerve the Sun at Sea with. There is a Line from the little hole in the *Sight-Vain* to the *Graduation* from which you count what's upon the great Arch. This great Arch is ſo large, that the degrees are ſub-divided into ſix parts, each part being 10 minutes of a degree, ſo that you may take it off to a near ſcantling; but to be more exact, that Arch hath commonly a diagonal Line on it, by which you may take it to ſeconds of a degree; but with care you may do as well without it.

II. *The Projection of the Croſs-ſtaff.*

Fig. II. First, upon a Board fitted for that purpoſe, draw the Line A E, and from A raiſe the perpendicular Line A L I, and (making A the center) deſcribe the Arch L E (which is a Quadrant) divide it into two parts in the point S, and the half S L divide into 90 equal parts, (though here 'tis but into 9, by reaſon of the ſmalneſs of the Circle): Theſe parts muſt be ſub-divided each into ten parts in your work of that largeneſs for uſe. And from A draw Lines from every ſingle degree and 10 minutes of a degree, as here is done to every ten degrees. This done, for the 20th ſide of your Scale, through the 20th diviſion, at 20, draw the Line B O parallel to A I, and the diviſions will be made by the Lines drawn from A.

Alſo draw (for your 60th ſide) a parallel Line to A I from 60 in the Circle, as C K, and the Lines from A divides that: The like from 90. And in this manner is the *Croſs-ſtaff projected*. But be very exact in dividing your Circle; for elſe it will fail much, it being the nature of a tangent Line to run ſo edging to a Line it cuts. The diviſions

diviſions being thus laid down on a Board, you may take them off and ſet them on your Staff provided for that purpoſe: If you will, you may make a tenth ſide after the ſame manner from 10 on the Circle.

Laſtly, for the length of the Croſſes, they be as followeth.

The Croſs for the ſide that goes but to 10 degrees, ſhall reach from 10 degrees to 8 *deg.* 31′ on the tenth ſide, or the half length of it is from 10 degrees to 9 *deg.* 12′.

The Croſs for the ſide graduated to 20 degrees, is twice the length of A B.

The Croſs of the thirtieth ſide ſhould reach upon the Graduation from 30 to 19 *deg.* 47′ (if you make ſuch a ſide) which indeed is common.

The Croſs for the ſide graduated to 60 degrees ſhould reach from 60 degrees (on that ſide) to 30 *deg.* 00′.

The Croſs for the ſide graduated to 90 degrees, ſhould reach from 90 to 36 *deg.* 52′.

The Uſe of this Staff in obſerving the Sun or Star.

PUt one of the Tranſomes on, and ſet the center-end of the Staff (that is the end at B) to the corner of your eye, and remove that Tranſome upon the Staff till you bring the center of the Sun and the Horizon to be juſt clear of the ends of the Tranſome, and ſo have you ſet the Staff well; but if the Sun or Star riſeth, it will require to be removed nearer in towards your eye; if falling, to be further out, (which you muſt not do) but keep what was at the utmoſt riſing, and the Tranſome will ſtand at the very degree and minute that the Sun or Star is at the higheſt, or the true *Meridian Altitude*, whoſe compt you may work by, as you are adviſed in Rules for that purpoſe to find the Latitude.

III. *Of the* Nocturnal.

Fig. III. THis Inſtrument is ſo generally known, that I need ſay but little to it; and indeed a man may take the *Guards* as well, or better, without it (if he be acuſtomed ſo to do); but for their ſakes that uſe it, I'll give a ſhort Deſcription thereof.

Its Description.

THat part of it with a handle hath the outer Circle divided into twelve parts for the twelve months, and each month into days. Now these are counted towards the left hand, and marked with the first letters of the months name, or more. There are two other Circles, the outermost is divided into 24 parts, for the 24 hours; the other into 29 parts, for the days of the Moons age, to find the Moons Southing and the Tydes.

Some make one sort of these Nocturnals, some another; one for the *Guards* of the *Little Bear*, the other for the *Pointers*; but you may know which is which: for that made for the *Guards* of the *Great Bear* (or the *Pointers*) have the 17th of *February* on the top; and if it be for the *Guards* of the *Little Bear*, the 21th of *April* is there. The back-part is divided into 32 points of the Compass, whereby you know the bearing of the Guard, and so (by the Table of the North Star) do find his declination; but I think (as I said before) a man may better guess at it, if he be so accustomed.

The next part hath a long Index, as it were, with the edge continued direct from the center, and that you turn to the day of the month; above that is a Circle divided into 24 hours: so that when this long Index is set to the day of the month, and the other turned to the *Guards*, the streight side of that other, gives the hour of the night upon the Circle.

The moveable part above hath one side thereof from the center, and (when you observe) must be turned to the *Guard*. Now in the center there is a hole through which you see the Pole-Star, and keep the moveable part above on the *Guard*, so you may see what Guard it is.

How to Observe with the Nocturnal.

WHen you observe with this Instrument, hold it by the handle, with the back-side towards you (but be sure you hold it upright, for what it wants of being so held, is a real error (which makes me say, a man may guess as near without it for the Guard) but the tip over against the handle is the best Guide you have for the holding of it upright): It being so held, look through the hole that is in the center upon the North Star, and the Guard, as I have said before.

To find the hour of the Night by the Nocturnal.

IF you would find the hour of the Night by the Guards, ſet the ſhort Index to the day of the month, (and be ſure keep it there) and hold it as I have ſhewed; and looking on the North Star through the hole, turn the long Index to the Guard, and the edge of the ſhort Index ſhall cut the hour of the Night; and likewiſe, find (on the backſide) what Guard it is (I mean, how they bear from the North Star) that ſo you may ſee the North Stars declination, either above or under the Pole.

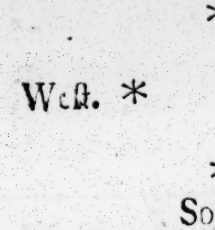
We might find near enough the Moons Southing, by this Inſtrument, and ſo Arithmetically the time of High Water; but I think the Rules for that (which I have inſerted) are much better, that this will not be uſed.

IV. *The declination and diſtance of the* Croſiers *from the South Pole.*

The NAMES.	Magnitude.	Declination Southerly. *deg. min.*	Diſt. from Sou. Pole. *de. min.*
The Weſt Croſier	3	56 : 55	33 : 05
The Eaſt Croſier	2	57 : 57	32 : 03
The South Croſier	1	61 : 28	28 : 32
The North Croſier	2	55 : 33	34 : 27

THe declination of theſe Croſiers have not been ſo well noted as to be in print before, (as I know of) and indeed the greateſt notice that I take of any of them, is the South Croſier, or the loweſt to the Southward, whoſe declination and diſtance from the South Pole, I do aſſert to be true, from my own experience, (not but that the reſt are ſo too) but I have not experienced them ſo much. I think my Brother Mr. *Andrew Norwood* made theſe Obſervations of them, as in the preceding Table.

This Conſtellation is called the *Croſiers*, becauſe they make a *Croſs*, as in this Figure. And this is obſerved of them, That when the *North* and *South Croſiers* are directly over one another, they are upon (or very near) the *Meridian*: So that by looking upon them, you may know when to obſerve them. They are the beſt Stars that I know, for obſervation to the Southwards of the Equinoctial.



CHAP. XVIII.

Rules to find the Latitude.

THis Book, ſo generally treating of *Navigation*, cannot want the Tables of the Suns *Declination*, and for that reaſon I have placed them here; and for both that and ſome other occaſions, that will be for the *Longitudes*, *Latitudes*, *Declinations*, and *Right Aſcenſions* of ſome of the principal Stars: I have ſet them down here, after the Tables of the *Suns Declination*. I have alſo ſet down the ſeaſons for the Stars coming upon the Meridian at four of the Clock in the Morning, by which you may gueſs their other times of coming upon the Meridian; for that Star that at any time propoſed is upon the Meridian at four of the Clock in the morning, will be upon the Meridian at three of the Clock about fifteen days after, and ſo about a month after, at two of the Clock; and that's the reaſon I ſet their ſeaſons down to them at four of the Clock in the Morning, becauſe you will have their ſeaſon backward the whole night, they coming ſooner & ſooner every night to the Meridian. If you deſire to know the time of a Stars coming to the Meridian for any day, you may ſubſtract the Right Aſcenſion of the Sun that day from the Right Aſcenſion of the Star (adding 24 hours) the remainder ſheweth how many hours after 12 of the Clock at Noon the Star will be upon the Meridian.

The Right Aſcenſion of the Sun for any day will be found by his Declination, and greateſt Declination, as I have ſhewed before. Notwithſtanding, I have here inſerted a Table of the Suns Right Aſcenſion for every degree of the Ecliptick. And for Stars near the Equinoctial,

or

Fig. I.

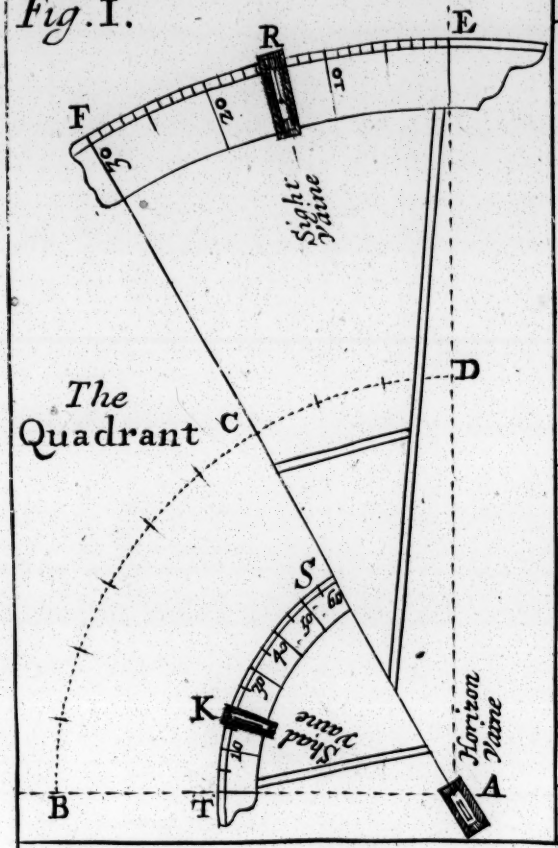
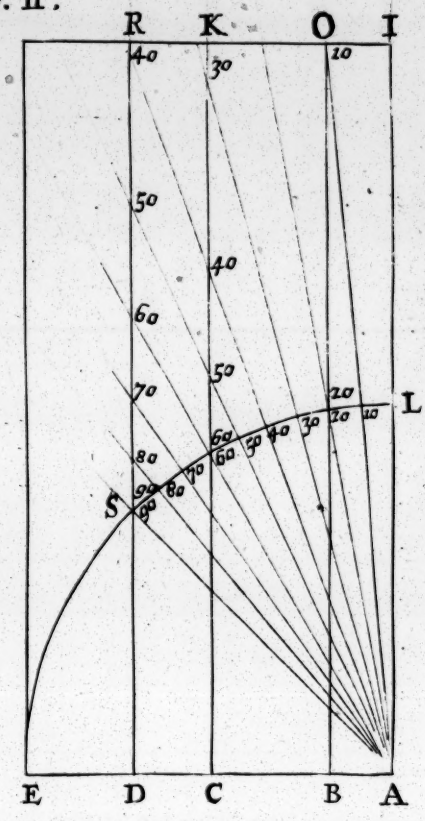
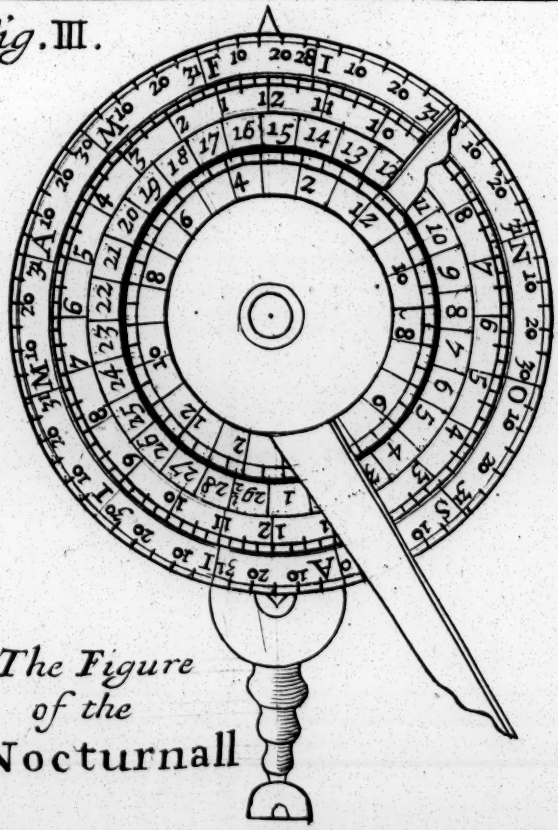


Fig. II.



The Crosstaffe

Fig. III.



The Figure of the **Nocturnall**

A Figure of the **Crosiers** *According to their Magnitudes and Distances.*

Fig. IV.

or 50 degrees from it, I have ſet down their *Longitudes* and *Latitudes*, that ſo the *Moons* place may be diſcovered by her *Longitude* from any of them, eſpecially in her 90th degree; whereby the *Longitude* at *Sea* or *aſhore*, may be nearly found: For the performance whereof, I have ſet down the Moons motion, and the beſt way I know, as you will ſee towards the latter end of this Book. I ſhall refer you to that, for farther ſatisfaction herein, and ſhall treat now of the Rules and Reaſons for working an Obſervation by the Sun or Star; which I am the willinger to demonſtrate, becauſe I am ſure many work Obſervations, and know not the reaſon why they adde or ſubſtract.

The Rules, and the Demonſtration of the Rules for finding the Latitude by the Suns height from the Horizon, or diſtance from the Zenith, by the help of the Table of the Suns Declination, are as followeth *viz.*

RULE I.

If the Sun be on the Meridian South, and have South Declination, ſubſtract the Declination from the Complement of the Meridian-Altitude of the Sun (or the diſtance from the Zenith) the Remainder is the Latitude of the place North; but if the Declination exceed the Zenith-diſtance, then ſubſtract it from the Declination, the Remainder is the Latitude South.

EXAMPLE 1.

Suppoſe being at Sea, and the Sun being obſerved to be on the Meridian South 37 *deg.* 30′ from the Zenith, or 52 *deg.* 30′ from the Horizon, and at the ſame time hath 12 *deg.* 00′ Declination South; What is the Latitude?

	m.	*d.*
Zenith-diſtance of the Sun	37	30
Suns Declination South, ſubſtract	12	00
The Latitude North	25	30

Demon-

Demonſtration.

Fig. I. LEt the Circle ADBC repreſent the *Meridian*, A the *Zenith*, B the *Nadir*, C D the *Horizon*; then I ſet off 37 *deg.* 30′ from A the Zenith, to F, and this is the Complement of the Suns heighth (or diſtance (at Noon) of the Sun from the Zenith); then conſidering the declination is *South*, I ſet off the 12 *deg.* Northward to Æ, and draw the Line Æ Æ for the *Equinoctial*: (for the Equinoctial lying 90 degrees from either Pole, muſt needs be to the North of the Sun when the declination is South.) K L is the Tropick of *Cancer*, and H I the Tropick of *Capricorn*: Hereby will appear plainly the reaſon of the Rule, why the declination muſt be ſubſtracted; for it ever holds good, that the Equinoctial heighth of the Sun from the Horizon, is equal to the Complement of the Latitude, and the diſtance of the Sun from the Zenith, equal to the Latitude; in ſuch caſes as theſe, and the declination being South, muſt be further from the Zenith, therefore the Equinoctial muſt be nearer to the Zenith, which is equal to the Latitude.

EXAMPLE. 2.

Suppoſe being at Sea, I obſerve the Sun to be on the Meridian South, and 10 *deg.* 00′ diſtant from the Zenith, and the declination being at the ſame time South 20 *deg.* 30′, What is the Latitude?

	m.	*d.*
The Suns declination South	20	30
The Suns diſtance from the Zenith South, ſubſtract	10	00
The Latitude South	10	30

Demonſtration.

Fig. II. THe Scheme being projected as before, the Suns declination being South, and the Sun diſtant 10 degrees South of the Zenith, I draw the parallel of the Suns declination F I, having firſt at 20 *deg.* 30′ Northward, drawn the Equinoctial Æ Æ, which falls of neceſſity 10 *deg.* 30′ to the North of the Zenith; and conſequently the Poles being 90 degrees diſtant on either ſide from the Equinoctial, the South Pole is 10 *deg.* 30′ above the Horizon at S, and the North Pole at N is ſo much depreſſed under the Horizon at D: ſo it is plain that the South Pole is elevated 10 *deg.* 30′ as C S, therefore the Latitude is South.

RULE

RULE II.

The Sun being on the Meridian, on the South, and the Declination being North, adde the Declination to the Zenith-distance of the Sun, the sum is the Latitude North.

EXAMPLE.

Suppose a Ship being at Sea, the Sun being observed on the South, on the Meridian 30 *deg.* 30′ from the Zenith, and the declination being then 15 *deg.* 30′ North, What is the Latitude?

	d.	*m.*
Suns distance from the Zenith	30	30
Suns declination North, to be added	15	30
Latitude North	46	00

Demonstration.

Fig. III. BY the Scheme it appears, that A F, the Suns distance from the Zenith, and F Æ, the declination, make the Equinoctial-distance from the Zenith, which is equal to the Latitude, and therefore in this case must be added together.

RULE III.

The Sun being on the Meridian, on the North, and hath North Declination, substract the Zenith-distance of the Sun from the Zenith, from the Declination, the Remainder is the Latitude Northerly; but if the Suns distance from the Zenith exceeds the Declination, then substract the Declination therefrom, the Remainder is the Latitude Southerly.

EXAMPLE 1.

The declination being 20 *deg.* 00′ North, the distance of the Sun from the Zenith to the North at Noon 12 *deg.* 30′, What is the Latitude?

	d.	*m.*
Suns declination North	20	00
Suns distance from the Zenith North, substract	12	30
Latitude North	07	30

Demonstra-

Demonstration.

Fig. I. LEt the Circle ADBC represent the *Meridian*, A the *Zenith*, B the *Nadir*, C D the *Horizon*; then I set off 37 *deg.* 30′ from A the Zenith, to F, and this is the Complement of the Suns heighth (or distance (at Noon) of the Sun from the Zenith); then considering the declination is *South*, I set off the 12 *deg.* Northward to Æ, and draw the Line Æ Æ for the *Equinoctial*: (for the Equinoctial lying 90 degrees from either Pole, must needs be to the North of the Sun when the declination is South.) K L is the Tropick of *Cancer*, and H I the Tropick of *Capricorn*: Hereby will appear plainly the reason of the Rule, why the declination must be substracted; for it ever holds good, that the Equinoctial heighth of the Sun from the Horizon, is equal to the Complement of the Latitude, and the distance of the Sun from the Zenith, equal to the Latitude; in such cases as these, and the declination being South, must be further from the Zenith, therefore the Equinoctial must be nearer to the Zenith, which is equal to the Latitude.

EXAMPLE. 2.

Suppose being at Sea, I observe the Sun to be on the Meridian South, and 10 *deg.* 00′ distant from the Zenith, and the declination being at the same time South 20 *deg.* 30′, What is the Latitude?

	m.	*d.*
The Suns declination South	20	30
The Suns distance from the Zenith South, substract	10	00
The Latitude South	10	30

Demonstration.

Fig. II. THe Scheme being projected as before, the Suns declination being South, and the Sun distant 10 degrees South of the Zenith, I draw the parallel of the Suns declination F I, having first at 20 *deg.* 30′ Northward, drawn the Equinoctial Æ Æ, which falls of necessity 10 *deg.* 30′ to the North of the Zenith; and consequently the Poles being 90 degrees distant on either side from the Equinoctial, the South Pole is 10 *deg.* 30′ above the Horizon at S, and the North Pole at N is so much depressed under the Horizon at D: so it is plain that the South Pole is elevated 10 *deg.* 30′ as C S, therefore the Latitude is South.

RULE

RULE II.

The Sun being on the Meridian, on the South, and the Declination being North, adde the Declination to the Zenith-distance of the Sun, the sum is the Latitude North.

EXAMPLE.

Suppose a Ship being at Sea, the Sun being observed on the South, on the Meridian 30 *deg.* 30′ from the Zenith, and the declination being then 15 *deg.* 30′ North, What is the Latitude?

	d.	*m.*
Suns distance from the Zenith	30	30
Suns declination North, to be added	15	30
Latitude North	46	00

Demonstration.

Fig. III. BY the Scheme it appears, that A F, the Suns distance from the Zenith, and F Æ, the declination, make the Equinoctial-distance from the Zenith, which is equal to the Latitude, and therefore in this case must be added together.

RULE III.

The Sun being on the Meridian, on the North, and hath North Declination, substract the Zenith-distance of the Sun from the Zenith, from the Declination, the Remainder is the Latitude Northerly; but if the Suns distance from the Zenith exceeds the Declination, then substract the Declination therefrom, the Remainder is the Latitude Southerly.

EXAMPLE 1.

The declination being 20 *deg.* 00′ North, the distance of the Sun from the Zenith to the North at Noon 12 *deg.* 30′, What is the Latitude?

	d.	*m.*
Suns declination North	20	00
Suns distance from the Zenith North, substract	12	30
Latitude North	07	30

Demonstra-

Demonſtration.

Fig. IV. THe Suns diſtance North from the Zenith is 12 *deg.* 30′ which is to be ſet off accordingly to F, and the declination being North, ſet off the declination 20 *deg.* 00′ towards the South; for ſo it ought to be, that the declination parallel may be on the North of the Equinoctial: ſo it will plainly appear, that the Line A F, the Suns diſtance from the Zenith, being taken from Æ F the Suns declination, or diſtance from the Equinoctial, muſt leave A Æ, the diſtance of the Equinoctial from the Zenith; which is equal to the Latitude.

EXAMPLE 2.

The Suns declination being, as before, 20 degrees North, and the Sun at the time of the obſervation was 40 *deg.* 15′ from the Zenith Northward, What is the Latitude?

	d.	*m.*
The diſtance of the Sun from the Zenith North	40	15
The Suns declination North, ſubſtract	20	00
The Latitude South	20	15

Demonſtration.

Fig. V. THe Suns diſtance from the Zenith being 40 *deg.* 15′, and the declination North, I firſt find the point F, ſetting the Zenith-diſtance to the North; then the declination being North, I ſet it off, being 20 *deg.* 00′ towards the South, and there is the Equinoctial, which I find to be Æ, which by the work F Æ being ſubſtracted from A F, leaves A Æ, the Equinoctial-diſtance from the Zenith, which is equal to the Latitude. Then ſetting off the Polar-diſtance from the Equinoctial 90 degrees, we ſee that the point N, or North Pole, is depreſſed under the Horizon at D, and S the South Pole elevated above the Horizon at C, 20 *deg.* 15′; ſo that C S is the Latitude or Elevation of the South Pole.

RULE

RULE IV.

If the Sun be on the Meridian in the North, and hath South Declination, adde the Declination to the Zenith-distance, the sum is the Latitude Southerly.

EXAMPLE.

Suppose the Suns declination to be 16 deg. 45′ South, and the Zenith-distance to the North be 29 *deg.* 45′, What is the Latitude?

	d.	*m.*
The Suns declination South	16	45
The Zenith-distance North	29	45
The Latitude South	46	30

Demonstration.

Fig. VI. THe Zenith-distance I set off from A to F; then considering that the declination is South, I set it off towards the North to Æ the Equinoctial, both which, *viz.* A F and F Æ, being added together, give the Equinoctial-distance from the Zenith A Æ, which is equal to N D, or C S the Latitude, and it is South, because the South Pole at S is elevated above the Horizon, and N the North Pole is depressed.

RULE V.

If the Sun hath no Declination, the Complement of the Altitude (or the Suns distance from the Zenith) is the Latitude. If the Sun be on the Meridian in the South, the Latitude is North; if the Sun be on the Meridian in the North, the Latitude is South.

Demonstration.

THis is plain without a Scheme: for when the Sun hath no declination, then it is in the Equinoctial; and in all the former Schemes it appears that the Equinoctial-distance of the Sun from the Zenith, is equal to the Latitude; and the Equinoctial being 90 degrees distant from the Poles, if the Sun be South of the Zenith in

Demonſtration.

Fig. IV. THe Suns diſtance North from the Zenith is 12 *deg.* 30′ which is to be ſet off accordingly to F, and the declination being North, ſet off the declination 20 *deg.* 00′ towards the South; for ſo it ought to be, that the declination parallel may be on the North of the Equinoctial: ſo it will plainly appear, that the Line A F, the Suns diſtance from the Zenith, being taken from Æ F the Suns declination, or diſtance from the Equinoctial, muſt leave A Æ, the diſtance of the Equinoctial from the Zenith; which is equal to the Latitude.

EXAMPLE 2.

The Suns declination being, as before, 20 degrees North, and the Sun at the time of the obſervation was 40 *deg.* 15′ from the Zenith Northward, What is the Latitude?

	d.	*m.*
The diſtance of the Sun from the Zenith North	40	15
The Suns declination North, ſubſtract	20	00
The Latitude South	20	15

Demonſtration.

Fig. V. THe Suns diſtance from the Zenith being 40 *deg.* 15′, and the declination North, I firſt find the point F, ſetting the Zenith-diſtance to the North; then the declination being North, I ſet it off, being 20 *deg.* 00′ towards the South, and there is the Equinoctial, which I find to be Æ, which by the work F Æ being ſubſtracted from A F, leaves A Æ, the Equinoctial-diſtance from the Zenith, which is equal to the Latitude. Then ſetting off the Polar-diſtance from the Equinoctial 90 degrees, we ſee that the point N, or North Pole, is depreſſed under the Horizon at D, and S the South Pole elevated above the Horizon at C, 20 *deg.* 15′; ſo that C S is the Latitude or Elevation of the South Pole.

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Suppose the Suns declination to be 16 *deg.* 45′ South, and the Zenith-distance to the North be 29 *deg.* 45′, What is the Latitude?

	d.	*m.*
The Suns declination South	16	45
The Zenith-distance North	29	45
The Latitude South	46	30

Demonstration.

Fig. VI. The Zenith-distance I set off from A to F; then considering that the declination is South, I set it off towards the North to Æ the Equinoctial, both which, *viz.* A F and F Æ, being added together, give the Equinoctial-distance from the Zenith A Æ, which is equal to N D, or C S the Latitude, and it is South, because the South Pole at S is elevated above the Horizon, and N the North Pole is depressed.

RULE V.

If the Sun hath no Declination, the Complement of the Altitude (or the Suns distance from the Zenith) is the Latitude. If the Sun be on the Meridian in the South, the Latitude is North; if the Sun be on the Meridian in the North, the Latitude is South.

Demonstration.

THis is plain without a Scheme: for when the Sun hath no declination, then it is in the Equinoctial; and in all the former Schemes it appears that the Equinoctial-distance of the Sun from the Zenith, is equal to the Latitude; and the Equinoctial being 90 degrees distant from the Poles, if the Sun be South of the Zenith in

the Equinoctial, then the North Pole must be above the Horizon, and therefore the Latitude North: If the Sun be in the Equinoctial to the North of the Zenith, the South Pole will be above the Horizon, and so the Latitude South, as is very plain in the former Schemes.

RULE VI.

If the Sun be in the Zenith, that is, 90 degrees above the Horizon, then the declination, either North or South, is the Latitude.

Demonstration.

Fig. VII. AS here the Sun being 10 degrees distance from the Equinoctial South from Æ to A, or having 10 degrees South declination, causeth the South Pole at S to be elevated 10 degrees above the Horizon at C; so that the Latitude is 10 degrees South, the same with the distance A Æ: so that the Sun being in the Zenith, the declination of the Sun is equal to the Latitude. The like is to be understood, if the declination were North, then would the Latitude be North, as is easie to be conceived.

RULE VII.

If you be within the Artick or Antartick Circles, and observe the Sun upon the Meridian, under the Pole, adde the Suns declination to the Complement of the Altitude (or distance from the Zenith) and substract the sum from 180 *degrees, the remainder is the elevation of the Pole.*

EXAMPLE.

As suppose the Sun hath 20 degrees North declination, and the Suns heighth on the Meridian under the Pole be 10 degrees, What is the Latitude?

	d.	*m.*
The Suns declination	20	00
Complement of the Altitude	80	00
Their sum	100	00
This taken from	180	00
Leaves the Latitude North	80	00

Demonstra-

Demonſtration.

Fig. VIII. FOr adding ÆF, the declination, to F A, the Compliement of the Altitude, it makes 100 degrees; which ſubſtracted from ÆAÆ 180 degrees leaves ÆA equal to CS, the Latitude.

The foregoing Seven Rules otherwiſe briefly Analized.

THe Suns *Meridian Altitude* obſerved at *Sea* or *Land* in any part of the World, the *Latitude* of that place, by help of them, may be known; in which there are ſeveral *Caſes*, according as the Sun hath either *North* or *South Declination*, and as the *Sun* is ſituate, he being either upon the *North* or *South ſide* of the *Meridian*.---The ſeveral Varieties are theſe which follow.

When the Sun is in the *Equinoctial*, having no *Declination*, and the *Meridian-Altitude* is obſerved on the

- SOUTH-ſide of the *Meridian*, — The *Meridian-Altitude* taken from 90 degrees, leaves the Elevation of the *North Pole*.
- NORTH-ſide of the *Meridian*, — The *Meridian-Altitude* taken from 90 degrees, leaves the Elevation of the *South Pole*.

When the Sun's *Declination* is

- NORTH, — If the *Meridian-Altitude* be leſs than 90 degrees, and the Sun upon the *South-ſide* of the *Meridian*, the *Suns Declination* being taken from the *Meridian-Altitude*, leaves the height of the *Equinoctial*; which taken from 90 degrees, gives the *Latitude North*.
- SOUTH, — If the *Meridian-Altitude* be leſs than 90 degrees, and the Sun upon the *South-ſide* of the *Meridian*, adde the *Meridian-Altitude* and *Declination* together; their ſum is the height of the *Equinoctial*; which taken from 90 degrees, leaves the *Latitude North*. But if the ſum of the *Declination* and *Altitude* exceed 90 degrees, take 90 degrees therefrom, the remainder is the *Latitude South*.

When the Sun's *Declination* is NORTH, If the *Meridian-Altitude* be leſs than 90 degrees, and the Sun upon the *North-ſide* of the *Meridian*, adde the *Altitude* and *Declination* together, their ſum is the height of the *Equinoctial*; which taken from 90 degrees, leaves the *Latitude South*. But if the ſum be above 90 degrees, take 90 degrees therefrom, the remainder is the *Latitude North*.

When the Sun's *Declination* is SOUTH, If the *Meridian-Altitude* be leſs than 90 degrees, and the Sun upon the *North-ſide* of the *Meridian*, ſubtract the *Declination* from the *Meridian-Altitude*; the remainder is the height of the *Equinoctial*; which taken from 90 degrees, leaves the *Latitude South*.

When the Sun's *Declination* is NORTH, SOUTH, If the *Meridian-Altitude* be juſt 90 degrees, the *Suns Declination* is the *Latitude* *North*. *South*.

If the *Meridian-Altitude* be obſerved under the *Pole*, within the bounds of the *Polar Circles*, in ſuch caſe the *Sun's Declination* muſt be taken from 90 degrees, and what remains is his diſtance from the *Pole*; which being added to the *Meridian-Altitude*, the ſum is the *Latitude* of the place.

CHAP. XIX.

How to find the diſtance of any two places upon the Terreſtrial Globe, by the Plain Scale.

I. *Two places which differ in Latitude onely, to find their diſtance.*

1. IF the two places have both either North or South Latitude, ſubſtract the leſſer out of the greater, the remainder is the degrees of diſtance; which multiplied by 60, gives the diſtance in miles.

Example. *London*, and *Tholous* in *France*, lie both under the ſame Meridian, and both on the North ſide of the Equinoctial: *London* hath

hath 51 *deg.* 30′, and *Tholous* 43 *deg.* both North Latitude; 43 *deg.* ſubſtracted from 51 *deg.* 30′, leaves 8 *deg.* 30′; which turn'd into miles by multiplying the degrees by 60, and adding for every minute one mile, makes 510 miles for the diſtance of thoſe two places.

2. If one of the places have North, and the other South Latitude, the ſum of the two Latitudes is the diſtance.

Example. *London* hath 51 *deg.* 30′ North, and the Iſland *Triſtan Decanha* in the Ethiopick Sea, hath Latitude South 38 *deg.* the ſum of the two Latitudes is 89 *deg.* 30′; which multiplied by 60, is 5370 miles, and ſuch is their diſtance.

II. *Two places which differ onely in Longitude, to find their diſtance.*

1. IF the two places propoſed, do both lie directly under the Equinoctial, and ſo have no Latitude, then their difference of Longitude, if leſs than 180 degrees, is their diſtance.

Example. The Iſland St. *Thomæ*, and the Iſland *Sumatra*, lie both under the Equinoctial, St. *Thoma* having Longitude 35 *deg.* 30′, and *Sumatra* 134 *deg.* 30′, their difference is 99 degrees; which reduced into miles, makes 5940 for their diſtance.

2. But if the two places lie not under the Equinoctial, but under ſome other Parallel, between either of the Poles, then proceed to find their diſtance, as followeth.

Let the two places be *London* and *Gipiſon* in *Ruſſia*, both in 51 *deg.* 30′ of North Latitude, and differing in Longitude 45 *deg.* Firſt, Take 60 *deg.* of your Scale of Chords, and with that diſtance on the point C, deſcribe the Circle Æ L Q I, and draw the Diameter Æ C Q. Secondly, (becauſe the places differ in Longitude 45 *deg.*) Take 45 *deg.* out of the Scale, and ſet them from Æ to M, and draw the Line M C. Thirdly, Take 51 *deg.* 30′ the Latitude of both the places out of your Scale, and ſet that diſtance from M to I, and draw the Line I B perpendicular to M C. Fourthly, Make the diſtance Æ D equal to M B, and draw the Line B D, ſo ſhall D B, meaſured upon your Scale of Chords, contain 27 *deg.* 40′; which reduced into miles, make 1660 for their diſtance. Fig. IX.

III. *Two*

III. *Two places which differ both in Longitude and Latitude, to find their distance.*

LEt the two places be *London*, in North Latitude 51 *deg.* 30′, and Longitude 26 *deg.* and *Hierusalem* in Latitude 31 *deg.* 40′, and Longitude 71 *deg.* Their difference of Longitude is 45 *deg.* Now to find their distance. First, With 60 degrees of your Chord, describe the Circle Æ L Q M, as before, and draw the Diameter Æ C Q. Secondly, Set 45 degrees, the difference of Longitude, from Æ to M, and draw C M. Thirdly, Set one of the Latitudes (as that of *London*) 51 *deg.* 30′ from M to I, and draw I B perpendicular to M C. Fourthly, Set the other Latitude 31 *deg.* 40′ from Æ to L, and draw L A perpendicular to Æ Q. Fifthly, Take the distance A B, and set it from A to E. Sixthly, Take the distance B I, and set it from L to K, and from L to H. Lastly, The distance from K to E, measured upon your Scale, will give you 38 *deg.* 51′ for the distance of the two places; which converted into miles, is 2331 miles.

This is, when the two places proposed are both in one and the same Hemisphere, as in this Example they are, both to the Northward of the Equinoctial. But if the two places proposed are seated one in the Northern, and the other in Southern Hemisphere, then the distance H E (L H being made equal to L K) gives the degrees of distance. As if *London* were one place in North Latitude 51 *deg.* 30′, and another place were in South Latitude 31 *deg.* 40′, differing in Longitude 45 *deg.* H E the distance being measured upon your Scale, at twice (because it is longer than the Scale) will give you 96 *deg.* for their distance, which is 5760 miles.

Here

Fig. I.

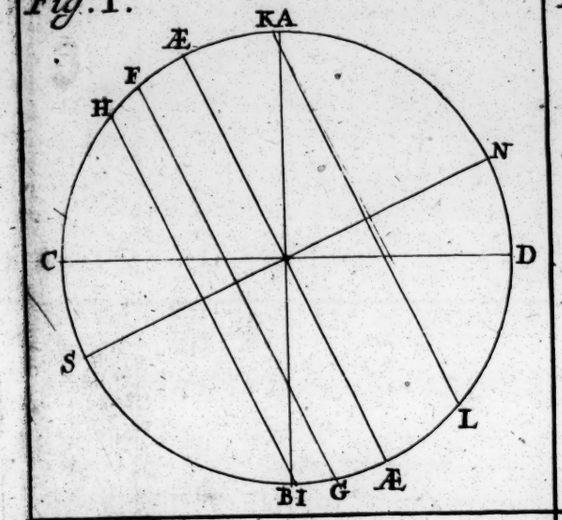


Fig. II.

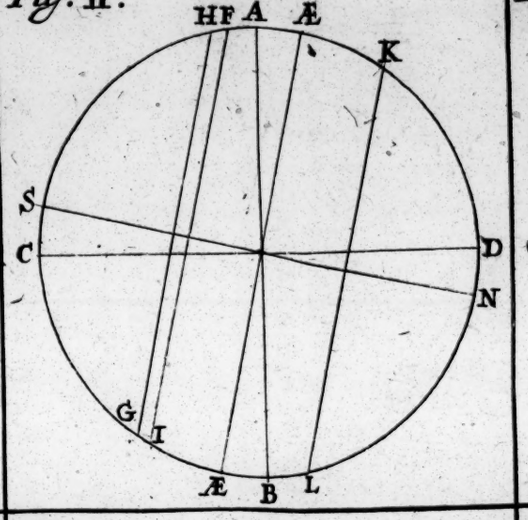


Fig. III.

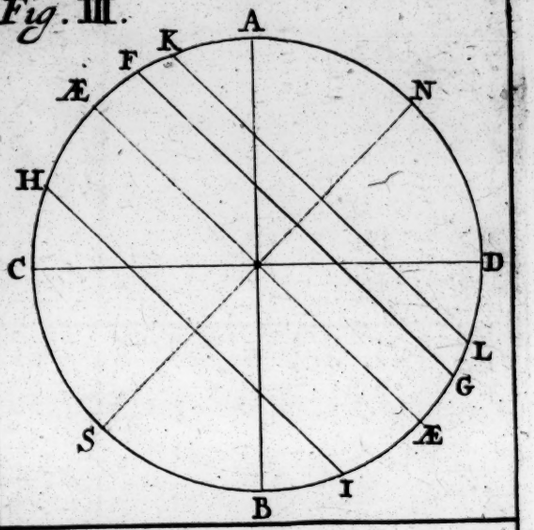


Fig. IV.

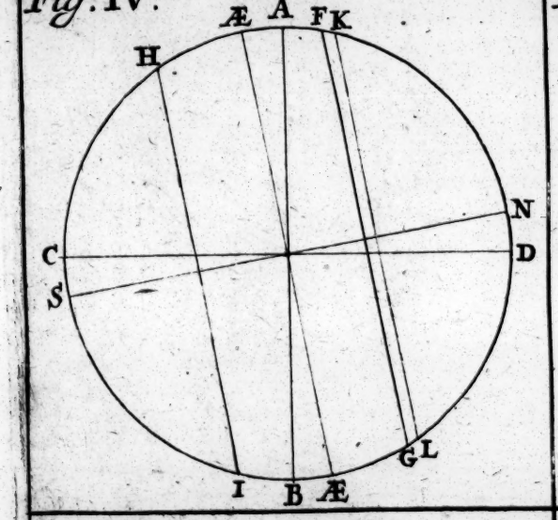


Fig. V.

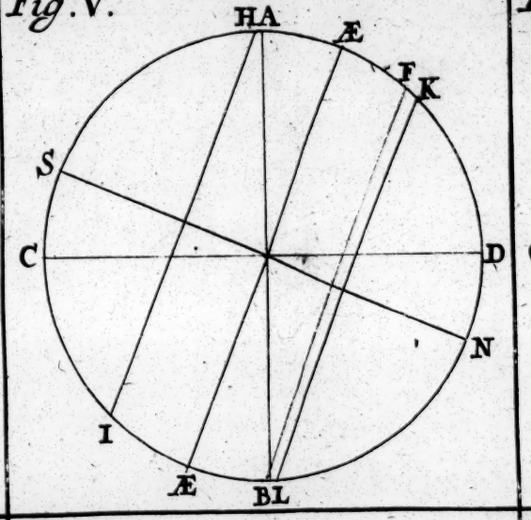


Fig. VI.

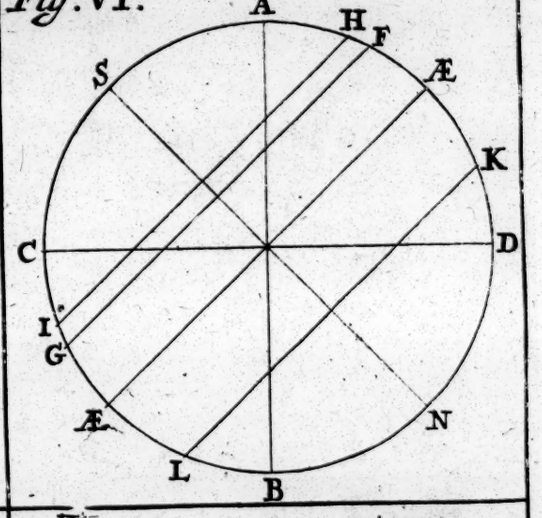


Fig. VII.

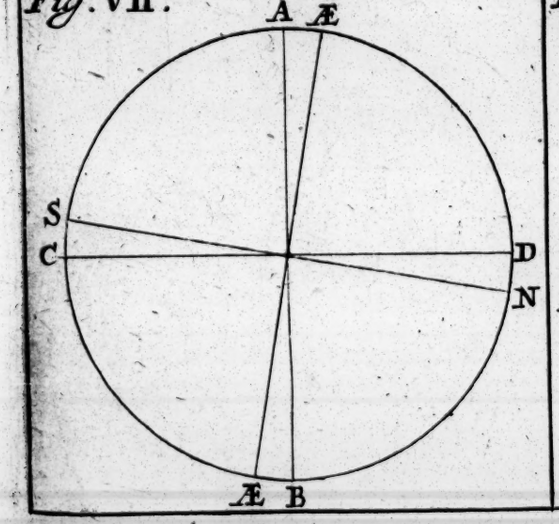


Fig. VIII.

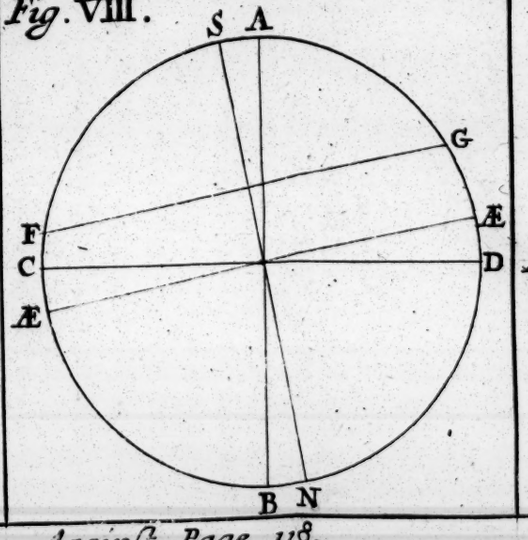
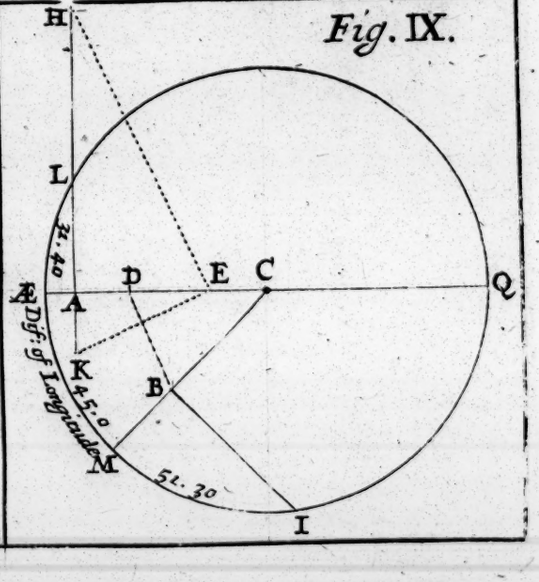


Fig. IX.



Against Page 118.

Here followeth the

TABLES

OF

The Sun & Stars

LONGITUDE, DECLINATION,

&c.

Subservient to find the

LATITUDE.

Days.	1677, *January.* ☉ Decl. de.	mi.	☉ place. de.	mi. ♑	1681, *February.* ☉ Decl. de.	mi.	☉ place. de.	mi. ♒	1685, *March.* ☉ Decl. de.	mi.	☉ place. de.	mi. ♓
1	21	41	22	02	13	43	23	30	03	22	21	34
2	21	31	23	03	13	23	[illegible]	31	02	58	22	34
3	21	21	24	04	13	03	[illegible]	31	02	34	23	34
4	21	10	25	05	12	43	26	32	02	11	24	33
5	20	59	26	07	12	22	27	32	01	47	25	33
6	20	47	27	08	12	01	28	33	01	23	26	33
7	20	35	28	09	11	40	29	33	01	00	27	32
8	20	23	29	10	11	18	♓	34	[illegible]		[illegible]	32
9	20	10	♒	11	[illegible]	57	[illegible]	34	[illegible]	12	[illegible]	31
10	19	56	01	12	10	35	02	34	[illegible]	12	[illegible]	30
11	19	43	02	13	10	14	03	35	North	35	01	30
12	19	29	03	14	09	52	04	35	[illegible]	59	02	[illegible]
13	19	15	04	15	09	30	05	35	01	22	03	28
14	19	00	05	16	09	07	06	35	01	46	04	28
15	18	45	06	17	08	45	07	35	02	10	05	27
16	18	30	07	18	08	23	08	36	02	33	06	26
17	18	14	08	19	08	00	09	36	02	56	07	25
18	17	58	09	20	07	37	10	36	03	20	08	24
19	17	42	10	21	07	[illegible]	11	36	03	[illegible]	09	23
20	17	25	11	22	06	[illegible]	12	36	04	[illegible]	10	22
21	17	08	12	23	06	28	13	36	04	30	11	21
22	16	51	13	23	06	05	14	36	04	53	12	20
23	16	33	14	24	05	42	15	36	05	16	13	19
24	16	15	15	24	05	19	16	36	05	39	14	18
25	15	57	16	25	04	56	17	35	06	01	15	17
26	15	39	17	26	04	32	18	35	06	24	16	16
27	15	20	18	27	04	09	19	35	06	47	17	15
28	15	01	19	28	03	45	20	35	07	09	18	14
29	14	42	20	28					07	32	19	12
30	14	23	21	29					07	54	20	11
31	14	03	22	30					08	16	21	10

Days.	1689, *April.* ☉ Decl.		1689, *April.* ☉ place		1693, *May.* ☉ Decl.		1693, *May.* ☉ place.		1697, *June.* ☉ Decl.		1697, *June.* ☉ place.	
	de.	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*
			♈				♉				♊	
1	08	38	22	08	18	07	21	13	23	11	20	54
2	09	00	23	07	18	22	22	11	23	15	21	51
3	09	22	24	05	18	36	23	09	23	18	22	49
4	09	43	25	04	18	51	24	06	23	21	23	46
5	10	04	26	02	19	05	25	04	23	23	24	43
6	10	26	27	01	19	19	26	02	23	26	25	40
7	10	47	27	59	19	32	26	59	23	27	26	37
8	11	08	28	58	19	45	27	57	23	29	27	34
9	11	28	29	56	19	58	28	54	23	29	28	32
10	11	49	♉	55	20	11	29	52	23	30	29	29
11	12	09	01	53	20	23	♊	49	23	30	♋	26
12	12	29	02	51	20	34	01	47	23	30	01	23
13	12	49	03	49	20	46	02	44	23	29	02	20
14	13	09	04	48	20	57	03	42	23	28	03	18
15	13	28	05	46	21	08	04	39	23	26	04	15
16	13	47	06	44	21	18	05	37	23	24	05	12
17	14	07	07	42	21	28	06	34	23	22	06	09
18	14	25	08	40	21	38	07	32	23	19	07	06
19	14	44	09	38	21	47	08	29	23	16	08	03
20	15	02	10	36	21	56	09	27	23	12	09	00
21	15	20	11	34	22	04	10	24	23	08	09	58
22	15	38	12	32	22	12	11	21	23	03	10	55
23	15	56	13	30	22	20	12	19	22	58	11	52
24	16	13	14	28	22	27	13	16	22	53	12	49
25	16	30	15	26	22	34	14	13	22	48	13	46
26	16	47	16	24	22	41	15	11	22	41	14	43
27	17	03	17	22	22	47	16	08	22	35	15	41
28	17	20	18	20	22	53	17	05	22	28	16	38
29	17	36	19	18	22	58	18	02	22	21	17	35
30	17	51	20	15	23	03	19	00	22	13	18	32
31					23	08	19	56				

Days.	1677, *July.* ☉ Decl.		☉ place.		1681, *August.* ☉ Decl.		☉ place.		1685, *September* ☉ Decl.		☉ place.	
	de.	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi*	*de.*	*mi.*	*de.*	*mi.*
			♋				♌				♍	
1	22	04	19	29	15	08	19	08	04	19	19	08
2	21	56	20	26	14	49	20	06	03	56	20	07
3	21	47	21	24	14	31	21	04	03	33	21	06
4	21	38	22	21	14	12	22	01	03	10	22	04
5	21	29	23	18	13	54	22	59	02	47	23	03
6	21	19	24	15	13	55	23	57	02	23	24	01
7	21	09	25	13	13	15	24	55	02	00	25	00
8	20	58	26	10	12	56	25	52	01	37	25	58
9	20	47	27	07	12	36	26	50	01	13	26	56
10	20	36	28	04	12	16	27	48		50	27	55
11	20	24	29	02	11	56	28	46		26	28	53
12	20	12	29	59	11	36	29	44		03	29	51
13	20	00	♌	56	11	16	♍	42		21	♎	50
14	19	47	01	54	10	55	01	40		44	01	48
15	19	34	02	51	10	34	02	38	01	08	02	51
16	19	21	03	48	10	13	03	36	01	31	03	50
17	19	07	04	46	09	52	04	34	01	55	04	48
18	18	53	05	43	09	31	05	32	02	18	05	47
19	18	39	06	40	09	09	06	30	02	42	06	45
20	18	24	07	38	08	48	07	28	03	05	07	43
21	18	10	08	35	08	26	08	27	03	28	08	42
22	17	55	09	33	08	04	09	25	03	52	09	40
23	17	39	10	30	07	42	10	23	04	15	10	38
24	17	23	11	28	07	20	11	21	04	38	11	36
25	17	07	12	25	06	58	12	19	05	02	12	34
26	16	51	13	24	06	35	13	18	05	25	13	33
27	16	34	14	20	06	13	14	16	05	48	14	31
28	16	18	15	18	05	50	15	15	06	11	15	30
29	16	00	16	15	05	28	16	13	06	34	16	28
30	15	43	17	13	05	05	17	11	06	57	17	27
31	15	26	18	11	04	42	18	10				

North. *South.*

Days.	1689, October.				1693, November.				1697, December.			
	☉ Decl.		☉ place.		☉ Decl.		☉ place.		☉ Decl.		☉ place.	
	de.	mi.	de.	mi.	de.	mi.	de.	mi.	de.	mi.	de.	mi.
			♎				♏				♐	
1	07	19	18	40	17	43	19	42	23	08	20	09
2	07	42	19	39	17	59	20	43	23	12	21	11
3	08	04	20	39	18	15	21	44	23	16	22	12
4	08	27	21	39	18	30	22	44	23	19	23	13
5	08	49	22	38	18	45	23	45	23	22	24	14
6	09	11	23	38	19	00	24	46	23	25	25	15
7	09	33	24	38	19	15	25	46	23	27	26	17
8	09	55	25	38	19	29	26	47	23	28	27	18
9	10	17	26	37	19	43	27	48	23	29	28	19
10	10	39	27	37	19	57	28	49	23	30	29	20
11	11	00	28	37	20	10	29	49	23	30	♑	21
12	11	22	29	37	20	23	♐	50	23	30	01	23
13	11	43	♏	37	20	35	01	51	23	29	02	24
14	12	04	01	37	20	47	02	52	23	28	03	25
15	12	24	02	37	20	59	03	53	23	26	04	26
16	12	45	03	37	21	10	04	54	23	23	05	28
17	13	05	04	37	21	21	05	55	23	21	06	29
18	13	25	05	37	21	32	06	56	23	17	07	30
19	13	45	06	38	21	42	07	57	23	14	08	31
20	14	05	07	38	21	51	08	58	23	10	09	33
21	14	25	08	38	22	01	09	59	23	05	10	34
22	14	44	09	38	22	09	11	00	23	00	11	35
23	15	03	10	39	22	18	12	01	22	54	12	36
24	15	22	11	39	22	26	13	02	22	48	13	37
25	15	40	12	39	22	33	14	03	22	42	14	39
26	15	59	13	40	22	40	15	04	22	35	15	40
27	16	17	14	40	22	47	16	05	22	28	16	41
28	16	34	15	40	22	53	17	06	22	20	17	42
29	16	52	16	41	22	59	18	07	22	12	18	44
30	17	09	17	41	23	04	19	08	22	03	19	45
31	17	26	18	42					21	54	20	46

Days.	1678, *January.* ☉ Decl.		☉ place.		1682, *February.* ☉ Decl.		☉ place.		1686, *March.* ☉ Decl.		☉ place.	
	de.	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*
			♑				♒				♓	
1	21	44	21	47	13	48	23	16	03	27	21	20
2	21	34	22	48	13	28	24	16	03	04	22	20
3	21	23	23	49	13	08	25	17	02	40	23	19
4	21	12	24	51	12	48	26	17	02	16	24	19
5	21	01	25	52	12	27	27	18	01	53	25	19
6	20	50	26	53	12	06	28	18	01	29	26	18
7	20	38	27	54	11	45	29	19	01	05	27	18
8	20	26	28	55	11	24	♓	19		42	28	17
9	20	13	29	56	11	02	01	19		18	29	17
10	20	00	♒	57	10	41	02	20		06	♈	16
11	19	06	01	58	10	19	03	20		29	01	15
12	19	32	02	59	09	57	04	20		53	02	15
13	19	18	04	00	09	35	05	20		17	03	14
14	19	04	05	01	09	13	06	21	01	44	04	13
15	18	49	06	02	08	51	07	21	02	04	05	12
16	18	33	07	03	08	28	08	21	02	27	06	12
17	18	18	08	04	08	05	09	21	02	51	07	11
18	18	02	09	05	07	43	10	21	03	14	08	10
19	17	46	10	06	07	20	11	21	03	38	09	09
20	17	29	11	07	06	57	12	21	04	01	10	08
21	17	12	12	08	06	34	13	21	04	24	11	07
22	16	55	13	08	06	11	14	21	04	47	12	06
23	16	38	14	09	05	48	15	21	05	10	13	05
24	16	20	15	10	05	25	16	21	05	33	14	04
25	16	02	16	11	05	01	17	21	05	56	15	03
26	15	43	17	12	04	38	18	21	06	19	16	02
27	15	25	18	12	04	14	19	21	06	41	17	00
28	15	06	19	13	03	51	20	20	07	04	17	59
29	14	47	20	14					07	26	18	58
30	14	28	21	14					07	49	19	57
31	14	08	22	15					08	11	20	55

South.

North.

Days.	1690, *April.* ☉ Decl. de.	mi.	☉ place de.	mi.	1694, *May.* ☉ Decl de.	mi	☉ place. de.	mi	1698, *June.* ☉ Decl. de.	mi	☉ place. de.	mi.
							♉				♊	
1	08	33	21	54	18	03	20	59	23	10	20	40
2	08	55	22	53	18	18	21	57	23	14	21	37
3	09	16	23	51	18	33	22	55	23	17	22	35
4	09	38	24	50	18	47	23	52	23	20	23	32
5	09	59	25	48	19	01	24	50	23	23	24	29
6	10	21	26	47	19	15	25	48	23	25	25	26
7	10	42	26	45	19	29	26	45	23	27	26	23
8	11	03	28	44	19	42	27	43	23	28	27	21
9	11	23	29	42	19	55	28	40	23	29	28	18
10	11	44	♌	40	20	08	29	38	23	30	29	15
11	12	05	01	39	20	20	♊	36	23	30	♋	12
12	12	24	02	37	20	32	01	33	23	30	01	09
13	12	44	03	35	20	43	02	31	23	29	02	06
14	13	04	04	33	20	54	03	28	23	28	03	04
15	13	24	05	32	21	05	04	26	23	26	04	01
16	13	43	06	30	21	16	05	23	23	25	04	58
17	14	02	07	28	21	26	06	20	23	22	05	55
18	14	21	08	26	21	35	07	18	23	19	06	52
19	14	39	09	24	21	45	08	15	23	16	07	49
20	14	58	10	22	21	54	09	13	23	13	08	47
21	15	16	11	20	22	02	10	10	23	09	09	44
22	15	34	12	18	22	10	11	07	23	04	10	41
23	15	52	13	16	22	18	12	05	23	00	11	38
24	16	09	14	14	22	26	13	02	22	54	12	35
25	16	26	15	12	22	33	13	59	22	49	13	32
26	16	43	16	10	22	39	14	57	22	43	14	30
27	16	59	17	08	22	46	15	54	22	37	15	27
28	17	16	18	06	22	52	16	51	22	30	16	24
29	17	32	19	04	22	57	17	48	22	23	17	21
30	17	47	20	01	23	02	18	46	22	15	18	18
31					23	07	19	43				

Days.	1678, *July.* ☉ Decl.		☉ place.		1682, *August.* ☉ Decl.		☉ place.		1686, *September.* ☉ Decl.		☉ place.	
	de.	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*
			♋				♌				♍	
1	22	06	19	15	15	12	18	54	04	25	18	54
2	21	58	20	13	14	54	19	52	04	02	19	53
3	21	29	21	10	14	36	20	50	03	39	20	51
4	21	40	22	07	14	17	21	47	03	15	21	50
5	21	31	23	04	13	58	22	45	02	52	22	48
6	21	21	24	02	13	39	23	43	02	29	23	47
7	21	11	24	59	13	20	24	41	02	06	24	46
8	21	01	25	56	13	01	25	38	01	42	25	45
9	20	50	26	53	12	41	26	36	01	19	26	43
10	20	39	27	51	12	21	27	34		56	27	42
11	20	27	28	48	12	01	28	32		32	28	41
12	20	15	29	45	11	41	29	30		09	29	40
13	20	03	♌	42	11	21	♍	28		15	♎	39
14	19	50	01	40	11	00	01	26		38	01	38
15	19	37	02	37	10	39	02	24	01	02	02	37
16	19	24	03	34	10	18	03	22	01	25	03	36
17	19	11	04	32	09	57	04	20	01	49	04	35
18	18	57	05	29	09	36	05	18	02	12	05	34
19	18	43	06	27	09	15	06	16	02	36	06	33
20	18	28	07	24	08	53	07	14	02	59	07	32
21	18	13	08	21	08	31	08	12	03	23	08	31
22	17	58	09	19	08	09	09	11	03	46	09	31
23	17	43	10	16	07	47	10	09	04	09	10	30
24	17	27	11	14	07	25	11	07	04	33	11	29
25	17	11	12	11	07	03	12	05	04	56	12	29
26	16	54	13	09	06	41	13	04	05	19	13	28
27	16	38	14	06	06	18	14	02	05	42	14	27
28	16	22	15	04	05	56	15	00	06	05	15	27
29	16	05	16	01	05	33	15	59	06	28	16	26
30	15	47	16	59	05	10	16	57	06	51	17	26
31	15	30	17	57	04	48	17	56				

North. *South.*

Days.	1690, *October.*			
	☉ Decl.		☉ place.	
	de.	*mi.*	*de.*	*mi.*
			♎	
1	07	14	18	25
2	07	36	19	25
3	07	59	20	25
4	08	22	21	24
5	08	44	22	24
6	09	06	23	24
7	09	28	24	23
8	09	50	25	23
9	10	12	26	23
10	10	34	27	23
11	10	55	28	23
12	10	16	29	23
13	11	38	♏	23
14	11	59	01	23
15	12	19	02	23
16	12	40	03	23
17	13	00	04	23
18	13	21	05	23
19	13	41	06	23
20	14	00	07	23
21	14	20	08	23
22	14	39	09	24
23	14	58	10	24
24	15	17	11	24
25	15	36	12	25
26	15	54	13	25
27	16	12	14	25
28	16	30	15	26
29	16	48	16	26
30	17	05	17	27
31	17	22	18	27

1694, *November.*			
☉ Decl.		☉ place.	
de.	*mi.*	*de.*	*mi.*
		♏	
17	38	19	28
17	55	20	28
18	11	21	29
18	26	22	30
18	42	23	30
18	57	24	31
19	12	25	32
19	26	26	32
19	40	27	33
19	54	28	34
20	07	29	35
20	20	♐	35
20	32	01	36
20	44	02	37
20	56	03	38
21	08	04	39
21	19	05	40
21	29	06	41
21	39	07	42
21	49	08	43
21	58	09	44
22	07	10	45
22	16	11	46
22	24	12	47
22	31	13	48
22	39	14	49
22	45	15	50
22	52	16	51
22	57	17	52
23	03	18	53

1698, *December.*			
☉ Decl.		☉ place.	
de.	*mi*	*de.*	*mi.*
		♐	
23	07	19	55
23	11	20	56
23	15	21	57
23	19	22	58
23	22	23	59
23	24	25	00
23	26	26	02
23	28	27	03
23	29	28	04
23	30	29	05
23	30	♑	07
23	30	01	08
23	29	02	09
23	28	03	10
23	26	04	11
23	24	05	13
23	21	06	14
23	18	07	15
23	15	08	16
23	11	09	18
23	06	10	19
23	01	11	20
22	56	12	21
22	50	13	23
22	44	14	24
22	37	15	25
22	30	16	26
22	22	17	27
22	14	18	29
22	05	19	30
21	56	20	31

Days.	1679, *January.* ☉ Decl.		☉ place		1683, *February.* ☉ Decl.		☉ place.		1687, *March.* ☉ Decl.		☉ place	
	de.	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*
			♑				♒				♓	
1	21	46	21	32	13	53	23	01	03	33	21	06
2	21	36	22	33	13	33	24	01	03	09	22	05
3	21	26	23	35	13	13	25	02	02	46	23	05
4	21	15	24	36	12	53	26	02	02	22	24	05
5	21	04	25	37	12	32	27	03	01	58	25	04
6	20	53	26	38	12	12	28	03	01	35	26	04
7	20	41	27	39	11	50	29	04	01	11	27	03
8	20	29	28	40	11	29	♓	04	00	47	28	03
9	20	16	29	41	11	08	01	05		24 *North.*	29	02
10	20	03	♒	42	10	46	02	05		00	♈	02
11	19	50	01	43	10	24	03	05		24 *South.*	01	01
12	19	36	02	44	10	02	04	06		47	02	00
13	19	22	03	45	09	40	05	06	01	11	03	00
14	19	07	04	46	09	18	06	06	01	35	03	59
15	18	52	05	47	08	56	07	06	01	58	04	58
16	18	37	06	48	08	34	08	06	02	22	05	57
17	18	22	07	49	08	11	09	07	02	45	06	56
18	18	06	08	50	07	48	10	07	03	09	07	56
19	17	50	09	51	07	26	11	07	03	32	08	55
20	17	33	10	52	07	03	12	07	03	55	09	54
21	17	16	11	53	06	40	13	07	04	18	10	53
22	16	59	12	54	06	17	14	07	04	42	11	52
23	16	42	13	55	05	53	15	07	05	05	12	51
24	16	24	14	55	05	30	16	07	05	28	13	50
25	16	06	15	56	05	07	17	06	05	50	14	49
26	15	48	16	57	04	43	18	06	06	13	15	47
27	15	29	17	58	04	20	19	06	06	36	16	46
28	15	11	18	58	03	57	20	06	06	58	17	45
29	14	52	19	59					07	21	18	44
30	14	32	21	00					07	43	19	43
31	14	13	22	00					08	05	20	41

Days.	1691, *April.* ☉ Decl.		☉ place.		1695, *May.* ☉ Decl.		☉ place.		1699, *June.* ☉ Decl.		☉ place.	
	de.	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*
			♈				♉				♊	
1	08	27	21	40	17	59	20	45	23	09	20	26
2	08	49	22	38	18	14	21	43	23	13	21	24
3	09	11	23	37	18	29	22	41	23	16	22	21
4	09	33	24	36	18	44	23	38	23	20	23	18
5	09	54	25	34	18	58	24	36	23	22	24	15
6	10	15	26	33	19	12	25	34	23	25	25	12
7	10	37	27	31	19	26	26	31	23	27	26	10
8	10	57	28	29	19	39	27	29	23	28	27	07
9	11	18	29	28	19	52	28	26	23	29	28	04
10	11	39	♉	26	20	05	29	24	23	30	29	01
11	11	59	01	25	20	17	♊	22	23	30	29	58
12	12	19	02	23	20	29	01	19	23	30	♋	56
13	12	39	03	21	20	40	02	17	23	29	01	53
14	12	59	04	19	20	52	03	14	23	28	02	50
15	13	19	05	18	21	03	04	12	23	27	03	47
16	13	38	06	16	21	13	05	09	23	25	04	44
17	13	58	07	14	21	23	06	07	23	23	05	41
18	14	16	08	12	21	33	07	04	23	20	06	38
19	14	35	09	10	21	42	08	01	23	17	07	36
20	14	53	10	08	21	51	08	59	23	14	08	33
21	15	12	11	06	22	00	09	56	23	10	09	30
22	15	30	12	04	22	08	10	53	23	06	10	27
23	15	47	13	02	22	16	11	51	23	01	11	24
24	16	05	14	00	22	24	12	48	22	56	12	21
25	16	22	14	58	22	31	13	45	22	50	13	19
26	16	39	15	56	22	38	14	43	22	44	14	16
27	16	55	16	54	22	44	15	40	22	38	15	13
28	17	12	17	52	22	50	16	37	22	32	16	10
29	17	28	18	50	22	56	17	35	22	25	17	07
30	17	44	19	47	23	01	18	32	22	17	18	04
31					23	06	19	29				

Days.	1679, *July.* ☉ Decl. de.	mi.	☉ place de.	mi.	1683, *August.* ☉ Decl. de.	mi.	☉ place. de.	mi.	1687, *September.* ☉ Decl. de.	mi.	☉ place. de.	mi.
			♋				♌				♍	
1	22	08	18	56	15	16	18	40	04	30	18	40
2	22	00	19	59	14	58	19	38	04	07	19	39
3	21	52	20	56	14	40	20	36	03	44	20	37
4	21	43	21	53	14	22	21	33	03	21	21	36
5	21	33	22	50	14	03	22	31	02	58	22	34
6	21	24	23	48	14	44	23	29	02	35	23	33
7	21	14	24	45	13	25	24	27	02	11	24	32
8	21	03	25	42	13	05	25	24	01	48	25	30
9	20	53	26	39	12	46	26	22	01	25	26	29
10	20	41	27	37	12	26	27	20	01	01	27	28
11	20	30	28	34	12	06	28	18	38	North.	28	27
12	20	18	29	31	11	46	29	16	14		29	26
13	20	06	♌	29	11	26	♍	14	09		♎	25
14	19	53	01	26	11	05	01	12	33	South.	01	24
15	19	41	02	23	10	44	02	10	56		02	23
16	19	27	03	21	10	23	03	08	01	20	03	22
17	19	14	04	18	10	02	04	06	01	43	04	21
18	19	00	05	15	09	42	05	04	02	07	05	20
19	18	46	06	13	09	20	06	02	02	30	06	19
20	18	32	07	10	08	58	07	00	02	54	07	18
21	18	17	08	08	08	37	07	58	03	17	08	17
22	18	02	09	05	08	15	08	57	03	40	09	16
23	17	47	10	02	07	53	09	55	04	04	10	16
24	17	31	11	00	07	31	10	53	04	27	11	15
25	17	15	11	57	07	09	11	51	04	50	12	14
26	16	59	12	55	06	46	12	50	05	14	13	14
27	16	42	13	52	06	24	13	48	05	37	14	13
28	16	26	14	50	06	01	14	46	06	00	15	12
29	16	09	15	48	05	39	15	45	06	23	16	12
30	16	52	16	45	05	16	16	43	06	46	17	11
31	15	34	17	43	04	53	17	42				

Days.	1691, *October.* ☉ Decl.		☉ place.		1695, *November.* ☉ Decl.		☉ place.		1699, *December.* ☉ Decl.		☉ place.	
	de.	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi*	*de.*	*mi.*	*de.*	*mi.*
			♎				♏				♐	
1	07	08	18	11	17	34	19	13	23	05	19	40
2	07	31	19	10	17	51	20	14	23	10	20	41
3	07	54	20	10	18	07	21	14	23	14	21	42
4	08	16	21	10	18	23	22	15	23	18	22	43
5	08	38	22	09	18	38	23	15	23	21	23	44
6	09	01	23	09	18	53	24	16	23	24	24	46
7	09	23	24	09	19	08	25	17	23	26	25	47
8	09	45	25	09	19	22	26	18	23	28	26	48
9	10	07	26	08	19	37	27	18	23	29	27	49
10	10	28	27	08	19	50	28	19	23	30	28	50
11	10	50	28	08	20	04	29	20	23	30	29	52
12	11	11	29	08	20	17	♐	20	23	30	♑	53
13	11	32	♏	08	20	29	01	22	23	29	01	54
14	11	53	01	08	20	41	02	22	23	28	02	55
15	12	14	02	08	20	58	03	23	23	27	03	57
16	12	35	03	08	21	05	04	24	23	25	04	58
17	12	55	04	08	21	16	05	25	23	22	05	59
18	13	16	05	08	21	27	06	26	23	19	07	00
19	13	36	06	08	21	37	07	27	23	16	08	02
20	13	56	07	09	21	47	08	28	23	12	09	03
21	14	15	08	09	21	56	09	29	23	07	10	04
22	14	34	09	09	22	05	10	30	23	02	11	05
23	14	54	10	09	22	14	11	31	22	57	12	07
24	15	13	11	10	22	22	12	32	22	51	13	08
25	15	31	12	10	22	30	13	33	22	45	14	09
26	15	50	13	10	22	37	14	34	22	39	15	10
27	16	08	14	11	22	44	15	35	22	31	16	11
28	16	25	15	11	22	50	16	36	22	24	17	13
29	16	43	16	12	22	56	17	37	22	16	18	14
30	17	01	17	12	23	01	18	39	22	07	19	15
31	17	18	18	13					21	59	20	16

Days.	1680, *January.* ☉ Decl. *de.*	*mi.*	☉ place. *de.*	*mi.*	1684, *February.* ☉ Decl. *de.*	*mi.*	☉ place. *de.*	*mi.*	1688, *March.* ☉ Decl. *de.*	*mi.*	☉ place. *de.*	*mi.*
			♑				♒				♓	
1	21	48	21	17	13	58	22	46	03	15	21	51
2	21	38	22	19	13	38	23	47	02	51	22	50
3	21	28	23	20	13	18	24	48	02	28	23	50
4	21	18	24	21	12	58	25	48	02	04	24	50
5	21	07	25	22	12	37	26	49	01	41	25	49
6	20	55	26	23	12	16	27	49	01	17	26	49
7	20	44	27	24	11	55	28	50	00	53	27	48
8	20	32	28	25	11	34	29	50	00	29	28	48
9	20	19	29	26	11	13	♓	50	00	06	29	47
10	20	06	♒	27	10	51	01	50	00	18	♈	47
11	19	53	01	29	10	30	02	51		42	01	46
12	19	39	02	30	10	08	03	51	01	05	02	45
13	19	25	03	31	09	46	04	51	01	29	03	45
14	19	11	04	32	09	24	05	51	01	52	04	44
15	18	56	05	33	09	01	06	52	02	15	05	43
16	18	41	06	34	08	39	07	52	02	39	06	42
17	18	25	07	35	08	16	08	52	03	03	07	41
18	18	10	08	35	07	54	09	52	03	26	08	40
19	17	54	09	36	07	31	10	52	03	49	09	39
20	17	37	10	37	07	08	11	52	04	13	10	38
21	17	20	11	38	06	45	12	52	04	36	11	37
22	17	03	12	39	06	22	13	52	04	59	12	36
23	16	46	13	40	05	59	14	52	05	22	13	35
24	16	30	14	41	05	36	15	52	05	45	14	34
25	16	11	15	41	05	13	16	52	06	08	15	33
26	15	52	16	42	04	49	17	52	06	30	16	32
27	15	34	17	43	04	26	18	52	07	53	17	31
28	15	15	18	44	04	02	19	51	07	15	18	30
29	14	56	19	44	03	39	20	51	07	38	19	28
30	14	37	20	45					08	00	20	27
31	14	18	21	46					08	22	21	26

Days.	1692, *April.* ☉ Decl.		☉ place.		1696, *May.* ☉ Decl.		☉ place.		1670, *June.* ☉ Decl.		☉ place.	
	de.	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi*	*de.*	*mi.*	*de.*	*mi.*
			♈				♉				♊	
1	08	44	22	24	18	11	21	29	23	12	21	10
2	09	06	23	23	18	26	22	27	23	16	22	07
3	09	27	24	21	18	40	23	24	23	19	23	04
4	09	49	25	20	18	55	24	22	23	22	24	01
5	10	10	26	18	19	09	25	20	23	24	24	59
6	10	31	27	17	19	22	26	17	23	26	25	56
7	10	52	28	15	19	36	27	15	23	28	26	53
8	11	13	29	14	19	49	28	13	23	29	27	50
9	11	34	♉	12	20	02	29	10	23	30	28	47
10	11	54	01	10	20	14	♊	08	23	30	29	45
11	12	15	02	09	20	26	01	05	23	30	♋	42
12	12	35	03	07	20	38	02	03	23	29	01	39
13	12	54	04	05	20	49	03	00	23	28	02	36
14	13	14	05	03	21	00	03	58	23	27	03	33
15	13	34	06	02	21	11	04	55	23	25	04	30
16	13	53	07	00	21	21	05	53	23	23	05	27
17	14	12	07	58	21	31	06	50	23	21	06	25
18	14	30	08	56	21	40	07	47	23	18	07	22
19	14	49	09	54	21	49	08	45	23	15	08	19
20	15	07	10	52	21	58	09	42	23	11	09	16
21	15	25	11	50	22	07	10	40	23	07	10	13
22	15	43	12	48	22	14	11	37	23	02	11	10
23	16	00	13	46	22	22	12	34	22	57	12	08
24	16	18	14	44	22	29	13	32	22	52	13	05
25	16	35	15	42	22	36	14	29	22	46	14	02
26	16	51	16	40	22	43	15	26	22	40	14	59
27	17	08	17	38	22	49	16	24	22	33	15	56
28	17	24	18	36	22	54	17	21	22	26	16	53
29	17	40	19	33	22	59	18	18	22	19	17	51
30	17	55	20	31	23	04	19	15	22	11	18	48
31					23	09	20	13				

Days.	1680, *July.* ☉ Decl.		☉ place.		1684, *August.* ☉ Decl.		☉ place.		1698, *September.* ☉ Decl.		☉ place.	
	de.	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*	*de.*	*mi.*
			♋				♌				♍	
1	22	02	19	45	15	03	19	24	04	13	19	24
2	21	54	20	42	14	44	20	22	03	50	20	23
3	21	45	21	39	14	26	21	19	03	27	21	22
4	21	36	22	37	14	07	22	17	03	03	22	20
5	21	26	23	34	13	48	23	15	02	40	23	19
6	21	16	24	31	13	29	24	13	02	17	24	17
7	21	06	25	28	13	10	25	10	01	54	25	16
8	20	55	26	26	12	51	26	08	01	30	26	15
9	20	44	27	23	12	31	27	06	01	07	27	14
10	20	33	28	20	12	11	28	04		43	28	13
11	20	21	29	17	11	51	29	02		20	29	11
12	20	09	♌	15	11	30	30	00	*North*	03	♎	12
13	19	56	01	12	11	10	♍	58		27	01	09
14	19	44	02	00	10	49	01	56		51	02	08
15	19	31	03	07	10	28	02	54	*South.*	14	03	07
16	19	17	04	04	10	07	03	52	01	38	04	06
17	19	03	05	01	09	46	04	50	02	01	05	05
18	18	49	05	59	09	25	05	48	02	25	06	04
19	18	35	06	56	09	03	06	46	02	48	07	04
20	18	20	07	54	08	42	07	44	03	11	08	03
21	18	06	08	51	08	20	08	42	03	35	09	02
22	17	50	09	48	07	58	09	41	03	58	10	01
23	17	35	10	46	07	36	10	39	04	21	11	00
24	17	19	11	43	07	14	11	37	04	45	12	00
25	17	03	12	41	06	52	12	35	05	08	12	59
26	16	46	13	38	06	28	13	34	05	31	13	59
27	16	30	14	36	06	07	14	32	05	54	14	58
28	16	13	15	34	05	44	15	30	06	17	15	57
29	15	56	16	31	05	22	16	29	06	40	16	57
30	15	38	17	29	04	59	17	27	07	0	17	56
	15	21	18	26		26	8	26				

Days.	1692, October.				1696, November.				1700, December.			
	☉ Decl.		☉ place.		☉ Decl.		☉ place.		☉ Decl.		☉ place.	
	de.	mi.	de.	mi.	de.	mi.	de.	mi.	de.	mi.	de.	mi.
			♎				♏				♐	
1	07	26	18	56	17	47	19	59	23	09	20	26
2	07	48	19	56	18	03	21	00	23	13	21	27
3	08	11	20	55	18	19	22	00	23	17	22	28
4	08	33	21	55	18	34	23	01	23	20	23	30
5	08	55	22	55	18	50	24	01	23	23	24	31
6	09	17	23	54	19	04	25	02	23	25	25	32
7	09	39	24	54	19	19	26	03	23	27	26	33
8	10	01	25	54	19	33	27	04	23	29	27	34
9	10	23	26	54	19	47	28	04	23	29	28	36
10	10	45	27	54	20	00	29	05	23	30	29	37
11	11	06	28	54	20	14	♐	06	23	30	♑	38
12	11	27	29	53	20	26	01	07	23	29	01	39
13	11	48	♏	53	20	39	02	08	23	28	02	40
14	12	09	01	52	20	51	03	08	23	27	03	42
15	12	30	02	53	21	02	04	09	23	25	04	49
16	12	50	03	54	21	13	05	10	23	23	05	44
17	13	11	04	54	21	24	06	11	23	20	06	45
18	13	31	05	54	21	34	07	12	23	16	07	47
19	13	51	06	54	21	44	08	13	23	13	08	48
20	14	10	07	54	21	54	09	14	23	08	09	49
21	14	30	08	54	22	03	10	15	23	04	10	50
22	14	49	09	55	22	12	11	16	22	58	11	51
23	15	08	10	55	22	20	12	17	22	53	12	53
24	15	27	11	55	22	28	13	18	22	47	13	54
25	15	45	12	56	22	35	14	19	22	40	14	55
26	16	03	13	56	22	42	15	20	22	33	15	57
27	16	21	14	56	22	49	16	22	22	26	16	58
28	16	39	15	57	22	55	17	23	22	18	17	59
29	16	56	16	57	23	00	18	24	22	09	19	00
30	17	13	17	58	23	05	19	25	22	01	20	01
31	17	30	18	58					21	52	21	03

The *Longitude, Latitude, Right Aſcenſion,* and *Declination* of certain fixed Stars between the Equinoctial and 50 deg. of Declination from it; with their *Magnitudes* and *Seaſons.*

Mag.	Their Names.		Long. de.	mi.		Latit. de.	mi.	R. Aſc. de.	mi.		Decli. de.	mi.	Seaſon.
2	The Whales Tail	♓	27	48	S	20	47	06	39	S	19	52	*July* 17
2	In the Girdle of *Andr.*	♈	25	41	N	25	59	12	42	N	33	52	*July* 23
3	In the Whales Back the Weſt	♈	07	03	S	16	55	13	17	S	12	43	*July* 24
3	In the Whales Back the Eaſt	♈	11	34	S	15	46	16	51	S	09	55	*July* 27
3	In the Whales Belly	♈	17	17	S	20	19	23	45	S	11	57	*Aug.* 3
3	In the Rams Horn the firſt	♈	28	29	N	07	08	23	47	N	17	36	*Aug.* 4
2	In the South Foot of *Andromida*	♉	09	31	N	27	46	25	51	N	40	41	*Aug.* 6
3	In the Rams Head	♉	02	58	N	09	57	27	05	N	21	51	*Aug.* 7
3	*Perſin*'s right Shoulder	♉	25	18	N	34	30	40	09	N	52	09	*Au.* 22
2	Briteſt in Whales Jaw	♉	09	39	S	12	37	41	13	S	02	45	*Au.* 23
3	*Maduſa*'s Head	♉	21	29	N	22	22	41	38	N	39	37	*Au.* 23
2	*Perſin*'s right Side	♉	27	09	N	30	05	44	51	N	48	33	*Au.* 26
3	Brighteſt of the *Pliades*	♉	25	16	N	04	00	51	52	N	23	01	*Sept.* 3
1	Bulls Eye, *Aldeboron*	♊	05	04	S	05	31	64	10	N	15	46	*Sep.* 17
1	Goat or Waggoner	♊	17	08	N	22	50	73	17	N	43	36	*Sep.* 27
1	In *Orion*'s left Foot	♊	12	09	S	31	11	74	37	S	08	38	*Sep.* 28
2	Waggoners right Foot	♊	17	52	N	05	20	76	15	N	28	15	*Sep.* 30
2	*Orion*'s left Shoulder	♊	16	15	S	10	53	76	48	N	05	59	*Octob.* 1
2	Firſt in his Girdle	♊	17	43	S	23	38	78	46	S	00	38	*Octob.* 3
	Second in his Girdle	♊	18	46	S	24	33	79	48	S	01	20	*Octob.* 4
	Third in his Girdle	♊	19	58	S	25	21	80	57	S	02	15	*Octob.* 5
	Wagg. right Shoulder	♊	25	20	N	21	28	83	53	N	44	51	*Octob.* 8
	Orion's right Shoulder	♊	24	04	S	16	06	84	16	N	07	17	*Octob.* 9
	Great Dogs Fore-foot	♋	02	34	S	41	18	92	03	S	17	49	*Oct.* 17
	In the bright Foot of the Twins [mouth	♋	04	23		06	48	94	33	N	16	38	*Oct.* 19
	The great Gog in his	♋	09	27	S	39	30	97	35	S	16	15	*Oct.* 22
	In the upper Head of the Twins	♋	15	33	N	10	02	108	15	N	32	34	*Nov.* 2

The *Longitude*, *Latitude*, *Right Aſcenſion*, and *Declination* of certain fixed Stars between the Equinoctial and 50 deg. of Declination from it; with their *Magnitudes* and *Seaſons*.

Mag.	Their Names.		Longit. de.	Longit. mi.		Latit. de.	Latit. mi.	R. Aſce. de.	R. Aſce. mi.		Decli. de.	Decli. mi.	Seaſons.
2	The leſſer Dog	♋	21	10	S	15	57	10	03	N	06	03	*Novem.* 4
2	In the lower head *Pollex*	♋	18	35	N	06	38	111	10	N	28	47	*Novem.* 5
1	*Hidray*'s Heart	♌	22	37	S	22	24	137	47	S	07	14	*Nov.* 30
1	Lions Heart	♌	25	09	N	00	26	147	36	N	13	35	*Decem.* 9
2	Lions Neck	♌	24	51	N	08	47	150	18	N	21	31	*Dec.* 11
2	Lions Back	♍	06	33	N	14	20	164	00	N	22	23	*Dec.* 23
1	Lions Tail	♍	16	55	N	12	18	172	50	N	16	28	*Dec.* 31
1	Virgins Spike	♎	19	08	S	01	59	196	53	S	09	21	*Jan.* 23
1	*Arcturus*	♎	19	31	N	31	22	210	15	N	21	19	*Feb.* 6
2	South Balance	♏	10	23	N	00	26	218	06	S	14	34	*Feb.* 14
2	North Balance	♏	14	40	N	08	35	224	45	S	08	04	*Feb.* 21
2	In the Crown the brighteſt	♏	07	30	N	44	23	230	06	N	27	54	*Feb.* 27
1	Scorpion's Heart	♐	05	05	S	04	27	242	15	S	25	34	*Marc.* 12
3	In *Ophiuchus* right foot	♐	15	53	N	02	16	254	55		20	30	*Marc.* 26
1	In the Harp, the brighteſt	♑	10	35	N	61	48	276	24		28	32	*April* 18
2	Eagles Heart, *alias* Vultures	♑	27	01	N	29	22	293	35		08	03	*May* 6
3	Dolphins Tail	♒	09	24	N	29	08	304	18		10	13	*May* 17
2	In the Swans Tail	♓	00	40	N	59	57	307	31	N	44	07	*May* 20
2	Water powers Leg	♓	04	14	S	08	10	339	14	S	17	37	*June* 20
1	Fomahant	♒	29	04	S	21	00	339	38	S	31	20	*June* 20
2	In *Pegaſus* Leg	♓	24	42	N	31	08	341	54	N	26	19	*June* 22
2	*Pegaſus* Shoulder	♓	18	48									
2	The Head of *Andromida*	♈	09	39	N	19	26	342	01	N	13	25	*June* 23
2	The laſt in *Pegaſus* Wing	♈	04	30		25	42	357	47	N	17	15	*July* 8
						12	35	359	03	N	13	18	*July* 9

The *Right Aſcenſion*, *Declination*, and *Diſtance* from the *North Pole*, of ſeveral Stars; with their *Seaſons* for obſervation.

The Names of the Stars.	R. Alce. de.	R. Alce. mi.	Decli. de.	Decli. mi.	Diſtanc. de.	Diſtanc. mi.	Seaſons.	
In the Breaſt of *Caſſiopeia*	05	29	54	42	35	18	*July*	16
The North Star	08	04	87	31	02	29	*July*	18
In the Hip of *Caſſiopeia*	009	16	58	54	31	06	*July*	19
In *Caſſiopeia*'s Knee	016	05	58	27	31	33	*July*	26
In *Caſſiopeia*'s Leg	022	43	61	59	28	01	*Auguſt*	2
In *Perſin*'s right Shoulder	040	09	52	09	37	51	*Auguſt*	20
In the great Bears Side	160	09	58	11	31	49	*Decemb.*	20
In the great Bears Back	160	37	63	34	26	26	*Decemb.*	20
In the great Bears Thigh	173	52	55	35	24	25	*January*	1
In Dragons Tail the laſt but one	175	56	71	37	18	23	*January*	1
In the great Bears Rump	179	37	58	54	31	06	*January*	7
Between her Tail and the Loins	188	58	40	37	49	23	*January*	16
Firſt in the great Bears Tail	189	41	57	50	52	10	*January*	16
The middlemoſt in her Tail	197	30	56	43	33	17	*January*	24
In the end of her Tail	203	30	51	03	38	57	*January*	30
In the bending of Dragons Tail	209	34	55	59	24	01	*Febr.*	5
The foremoſt Goured	222	45	75	38	14	22	*Febr.*	19
The hindermoſt Gourd	231	09	73	18	16	42	*Febr.*	28
In Dragons Head foremoſt	260	44	52	35	37	25	*April*	1
In Dragons Head hindermoſt	267	12	51	37	38	23	*April*	9
In *Cepheus* Girdle	311	02	69	08	20	59	*June*	2
In his left Foot	333	53	64	15	25	16	*June*	15
In the Back of *Caſſiopeia*'s Chear	357	54	57	18	32	42	*July*	8

A Table of the Suns Right Ascension for every Degree of the Ecliptick.

Degrees.	♈		♉		♊		♋		♌		♍	
0	0	0	27	54	57	48	90	0	122	12	152	6
1	0	55	28	51	58.	51	91	5	123	14	153	3
2	1	50	29	49	59	53	92	11	124	16	154	1
3	2	45	30	46	60	56	93	16	125	19	154	58
4	3	40	31	44	61	59	94	22	126	20	155	54
5	4	35	32	42	63	2	95	27	127	22	156	51
6	5	30	33	40	64	6	96	32	128	24	157	48
7	6	25	34	38	65	9	97	38	129	25	158	44
8	7	21	35	37	66	13	98	43	130	26	159	40
9	8	16	36	36	67	17	99	48	131	27	160	37
10	9	11	37	34	68	21	100	53	132	28	161	33
11	10	6	38	33	69	25	101	58	133	28	162	29
12	11	1	39	33	70	29	103	3	134	29	163	25
13	11	57	40	32	71	34	104	8	135	29	164	20
14	12	52	41	31	72	38	105	13	136	29	165	16
15	13	48	42	31	73	43	106	17	137	29	166	12
16	14	44	43	31	74	47	107	22	138	29	167	7
17	15	40	44	31	75	52	108	26	139	28	168	3
18	16	35	45	31	76	57	109	31	140	27	168	58
19	17	31	46	32	78	1	110	35	141	27	169	54
20	18	27	47	32	79	7	111	39	142	26	170	49
21	19	23	48	33	80	12	112	43	143	24	171	44
22	20	20	49	34	81	17	113	47	144	23	172	39
23	21	16	50	35	82	22	114	51	145	22	173	35
24	22	12	51	36	83	28	115	54	146	21	174	30
25	23	9	52	38	84	33	116	57	147	18	175	25
26	24	6	53	40	85	38	118	1	148	16	176	20
27	25	2	54	41	86	44	119	4	149	14	177	15
28	25	59	55	44	87	49	120	7	150	11	178	10
29	26	56	56	46	88	55	121	9	151	9	179	5
30	27	54	57	48	90	0	122	12	152	6	180	1

A Table of the Suns Right Aſcenſion for every Degree of the Ecliptick.

Degrees.	♎		♏		♐		♑		♒		♓	
0	180	0	207	54	237	48	270	0	302	12	332	6
1	180	55	208	51	238	51	271	5	303	14	333	3
2	181	50	209	49	239	53	272	11	304	16	334	1
3	182	45	210	46	240	56	273	16	305	19	334	58
4	183	40	211	44	241	59	274	22	306	20	335	54
5	184	35	212	42	243	2	275	27	307	22	336	51
6	185	30	213	40	244	6	276	32	308	24	337	48
7	186	25	214	38	245	9	277	38	309	25	338	44
8	187	21	215	37	246	13	278	43	310	26	339	40
9	188	16	216	36	247	17	279	48	311	27	340	37
10	189	11	217	34	248	21	280	53	312	28	341	33
11	190	6	218	33	249	25	281	58	313	28	342	29
12	191	2	219	33	250	29	283	3	314	29	343	25
13	191	57	220	32	251	34	285	8	315	29	344	20
14	192	52	221	31	252	38	286	13	316	29	345	16
15	193	48	222	31	253	43	287	17	317	29	346	12
16	194	44	223	31	254	47	288	22	318	29	347	7
17	195	40	224	31	255	52	289	26	319	28	348	3
18	196	35	225	31	256	57	290	31	320	27	348	58
19	197	31	226	32	258	1	291	35	321	27	349	54
20	198	27	227	32	259	7	292	39	322	26	350	49
21	199	23	228	33	260	12	293	43	323	24	351	44
22	200	20	229	34	261	17	294	47	324	23	352	39
23	201	16	230	35	262	22	295	51	325	22	353	35
24	202	12	231	36	263	28	296	54	326	21	354	30
25	203	9	232	38	264	33	297	57	327	18	355	25
26	204	6	233	40	265	38	298	1	328	16	356	20
27	205	2	234	41	266	44	299	4	329	14	357	15
28	205	59	235	44	267	49	300	7	330	11	358	10
29	206	56	236	46	268	55	301	9	331	9	359	5
30	207	54	237	48	270	0	302	12	332	6	360	0

A Table of the North Stars height, above or under the Pole, upon every Points bearing of the foremoſt Guard from it.

Points of the Compaſs	For the foremoſt Guard.	
W S W	0 15	The North Star above the Pole.
W by W	0 44	
Weſt	1 11	
W by N	1 36	
W N W	1 58	
N W by W	2 14	
N W	2 25	
N W by N	2 30	
N N W	2 29	
N by W	2 22	
North	2 09	
N by E	1 52	
N N E	1 29	
N E by N	1 02	
N E	2 35	
N E by E	2 06	
E N E	0 22	The North Star under the Pole.
E by N	0 52	
East	1 18	
E by S	1 41	
E S E	2 01	
S E by E	2 16	
S E	2 25	
S E by S	2 30	
S S E	2 29	
S by E	2 22	
South	2 11	
S by W	1 55	
S S W	1 34	
S W by S	1 10	
S W	0 43	
S W by W	0 14	

The Uſe of this Table.

ADmit I obſerve the *North Star* when it is a N N W *Guard*; I look in the Tables, and againſt N N W I find 2 *deg.* 29′: this 2 *deg.* 29′ muſt be ſubſtracted from the Altitude of the Star taken by your Staff, and the remainder is the *Latitude*; becauſe the Star was above the Pole, or higher than the Pole, by ſo much, as in the Table.

Admit I obſerve the Star when he is under the Pole upon a S S E *Guard*; I look, and find it is under the Pole 2 *deg.* 29′, or lower than the Poles Elevation by ſo much: therefore I muſt adde it to the Altitude taken, and it gives the *Latitude*. The like is to be underſtood at any other time; but I ſite theſe times, becauſe they are the beſt times for obſerving the Star, in regard of its ſlow aſcent or deſcent at thoſe times: for you ſee if you gueſs the bearing of the Guard a whole point amiſs, it will be no ſenſible errour, the Declination altering but 1′ in a whole point.

Upon an Eaſt or Weſt Guard is a good time, becauſe by obſerving the North Star, and Guard, to be both of an height, you are ſure the Guard is an Eaſt or Weſt Guard. Thus much of the Uſe of theſe Tables.

CHAP.

CHAP. XX.

To find the Prime, the Epact, the Moons Age, &c.

1. *To find the* Prime *or* Golden Number.

THe *Prime* signifies 19 years, in which time the Moon makes all her Revolutions and Aspects with the Sun, and is returned to the same place in the Zodiack that she was 19 years before.

To find it, adde 1 to the year of our Lord, and that sum divide by 19, the remainder of the division is the *Prime* that year.

Example, for the Year 1684.

Adde 1 to the year, and 'tis 1685; which divide by 19, leaves for the *Prime* 13, which is the remainder of the division.

2. *To find the* Epact.

THe *Epact* is the difference that is made in a year between the Sun and Moons Revolution; and 'tis thus found:

See what the *Goulden Number* is that year, and divide it by three: Now for every unite that is left of the division, count 10, and adde it to the *Prime*; if the number exceed 30, the *Epact* is what it is above 30; if it be just 30, the *Prime* and *Epact* that year are both one; if it be less than 30, the number it self is the *Epact*.

Example.

Let the *Prime* be as before, (for the year 1684,) 13 I divide it by 3, and the remainder of the division is 1: this I call 10, and adde it to the *Prime* 13, it makes 23 the *Epact* that year.

3. *To find the* Moons Age.

ADde the day of the month, the months from *March* (counting *March* one) and the *Epact* for the year, all three together, and the ſum is the *Moons Age*, if it be leſs than 30; but if it be more than 30, caſt away 30, and the remainder is the *Moons Age*. Onely obſerve to tell the months from *March*, thus: for *March* 1, *April* 2, *May* 3, *June* 4, *July* 5, *Auguſt* 6, *September* 7, *October* 8, *November* 9, *December* 10, *January* 11, *February* 12.

Example.

Let it be required to know the *Moons Age* the 20th of *Septem.* 1684: I adde the *Epact* 13, and 7 for the months from *March*, and 20 the day of the month together, and it makes 40, from which I take 30, and the remainder is the *Moons Age* that day, namely 10 days old.

13	
07	
20	
40	

If you would know when it is *Full Moon*, it is what her Age wants of 15; and for her *Change*, what her Age wants of 30.

4. *To find the time of High Water, by the Moons Age.*

ADmit it be certainly known, that at a place it flows at 6 of the Clock at *Full* and *Change*, I demand what time 'tis *Full Sea* when the Moon is 7 days old.

Example 1.

Multiply the Moons Age by 4, and that product divide by 5, and the quotion ſhall be the hours, the remainder of the diviſion the minutes after 6 of the Clock in the morning, that 'tis Full Sea. In this caſe it is 5 hours and $\frac{3}{5}$ of an hour, or 36 minutes. I ſay then, that when the Moon is 7 days old, it flows 5 ho. 36′ later than 6 of the Clock, which is 11 of the Clock 36 minutes.

7	(3	(ho.
4	28	5
28		5

Example

Example 2.

Admit the Moon were 14 days old, I demand the time of Full Sea; I multiply and divide, and the quotion is 11 ho. 12′; which I adde to 6 ho. and it makes 17 ho. 12′; from which if you take 12 hours, the remainder is the hour of *High Water* in the afternoon, which is 5 a Clock 12′.

Example 3.

If the Moon were 15 days old, I multiply and divide, and find the quotion is 12, and the remainder is 00; from whence I conclude 'tis High Water at 6 of the Clock, and that it is a full Moon. Now after that time of her *Full*, you may reject 15 days of her Age, and reckon her Age above the Full, as though it were her Age indeed.

Example 4.

Admit the Moon were 19 days old; I multiply and divide, and the quotion and remainder is 15 ho. 12′; which adde to 6 hours, gives 9 of the Clock 12′ for *High Water*, in the afternoon or morning. (There may be 22′ or thereabouts, added for the afternoon Tyde, because of the distance of time.) But now I say, if in this Example you had neglected the 15 days of the Moons Age, and multiplied 4 by 4, it would have been 16; and that product divided by 5, would have been 3 ho. and 12′; which added to 6 hours, is the morning Tyde, 9 of the Clock 12′.

5. *To find what year it is from* Leap-year.

DIvide the year of our Lord by four, and the remainder of the division is *Leap-year*; or if you neglect the thousand, and the hundreds, and the scores, and divide the remainder which is under a score, it gives the same thing.

Example 1.

What year from Leap-year is 1684? Here, if I divide 1684 by 4, the remainder is 0; and if I divide 4 by 4 (and neglect the ſcores and all above it) the remainder is 0: ſo that from hence I conclude this year 1684 is *Leap-year*.

(0
4 1684 (421
4
4
(0
4 (1
4

Example 2.

What year from *Leap-year*, is 1686? I divide 6 by 4, and the remainder of the diviſion is 2: from whence I conclude, it's the *ſecond year* from *Leap-year*.

(2
6 (1
4

6. *To find the* Dominical Letter *for* 1684.

ADde the year of our Lord	1684
And one fourth of 1684, which is	0421
And 4, together	0004
The ſum is	2109

Divide that ſum by 7, and note the remainder of the diviſion, which here is 2: ſubſtract it from 7, and the remainder is 5. I ſay then the Dominical Letter is the fifth Letter in the Alphabet, namely E, for the year 1684.

(2
7 2109 (301
7
7

WHen I was a Youth of about fifteen years of age, I went to Sea under the command of Captain *Kempthorne* of *New England*; and after ſome hardſhip, and about eight months time ſpent on that Voyage, we loſt our ſhip at St. *Antonies* (one of the *Cape de Verde* Iſlands) and to tell what we endured then, would be too long a digreſſion: but to be ſhort, we built a Boat out of the pieces of the ſhip that drove aſhore, and went over to St. *Vincent* (an Iſland thereby) where was ſome Bandeded *Portugals*, Roman Catholicks in their Perſwaſion, and it being *Sunday*, they had a Kid a roſting; but we

had lost a day, and counted it *Saturday*, and thought we should have had the Kid, because it was their fifth day, but found the contrary, and by them were satisfied that it was *Sunday*, or else had gone to Sea in our Boat and missed *Barbadoes* (for ought I know); but we proceeded in our Voyage and arrived in our Boat very safe fifteen Souls of us, (Gods Name be praised.) Now this is Argument enough to me to set down the following Rules to find the day of the Month.

And 1. *To find what day of the Week the first of* March *falls on, my Father comprized these Verses.*

Some of the Year, one forth and two,
Divide by seven, the rest count you.

From *Sunday* to the first of *March*, including both.

1. *Example Anno* 1684.

The sum of the year is	1684
The one forth part of it is	421
To which adde	02
The sum is	2107

Which sum divide by 7, there remains 0 of the division; from whence I conclude, that this year the first day of *March* is of a *Saturday*. If the remainder of the division had been 1, I would have counted it *Sunday*; if 2, *Munday*; if 3, *Tuesday*; if 4, *Wednesday*; if 5, *Thursday*; if 6, *Friday*; if 7 or 0, *Saturday*.

(0
2107 (300)
777

2. *Example* 1685.

The sum of the year is	1685
The $\frac{1}{4}$ of that sum is	421
To which adde	2
Sum	2108

Which sum divided by 7, leaves the remaining part of the division to be 1: from whence I conclude the first day of *March* will be of a *Sunday* the next year 1685.

(1
2108 (301)
777

Secondly,

Secondly, *To find which of the first seven days of any month is that day of the week with the first of* March.

For the ease of memory, my Father comprized this Distick.

1 *March.*	5 *April.*	3 *May.*	7 *June.*	5 *July.*	2 *August.*
An	end	comes	grateful	ever	blest,
From	Death	and	Fears	contagious	Guest.

September 6.	*October* 4.	*November* 1.	*December* 6.	*January* 3.	*February* 7.

These twelve *words* signifie (in their first *letters*) twelve numbers of the twelve *Months* of the *Year*, beginning with *March*. (A) then being the *first letter* in the Alphabet, signifies the first of *March*; (E) the *fifth* letter, signifies the 5th of *April*; (C) the *third* letter, signifies the third of *May*; (G) the *seventh* letter, signifies the 7th of *June*: and so proceeding with all the rest. Now these days of each month are all the same week-day that the first of *March* is: As, if the the first of *March* be *Sunday*, then the 5th of *April* is *Sunday*, and so is the third of *May*, and the 7th of *June*, and the 5th of *July*, and the second of *August*, and the 6th of *September*, and the 4th of *October*, and the first of *November*, and the 6th of *December*, and the third of *January*, and the 7th of *February*. Or if the first of *March* had been any day else of the week, the rest would have been the same day of the week, *&c.*

Thirdly, *Admit I know not the day of the week, nor also what week it is in the month, whether the first, second, third, or fourth; I demand the day of the month.*

Example.

Suppose the fourth week in *June* 1684. I would know what day of the month *Munday* is.

First, find the first of *March* this year, as hath been shewed.

The remaining part of the division is 0, therefore, according to the Rule, the first of *March* was of a *Saturday*. And by the preceding *Distick*, the 7th of *June* was of a *Saturday*; and then must the next *Saturday* be the 14th (for the second week in *June*) and the 21th of a *Saturday* for the third week, and the 28th of a *Saturday* for the fourth week; (to which adde *Sunday* and *Munday*, which is two days) and it makes *Munday* in the fourth week in *June* to be on the 30th day: The like for any day else.

1684	
421	
2	2 x 0 7 (301)
2107	7 7 7

It may fall out, that a man is to seek what week it is of a month, whether the first, second, third, or fourth, and yet he may know what day of the week it is two: But now in this case, how shall a man do to know what day of the month that day of the week is?

For this (the best way that I know) is to help himself by the *Moons Age*, if he can conjecture what age she is within a few days; which he may do some way or other, either by her bigness, or her following the Sun upon her increasing, or rising after the Sun upon her decreasing: or if a man be ashore, he may guess within a few days the age of the Moon by the Tydes.

This premised, that we may guess at the Moons age within a few days, we'll state the Question.

Fourthly, *Admit upon a certain* Munday *in* July 1684, *I would know the day of the month, but know not what week of the month this* Munday *is, whether the first, second, third or fourth, and so not whether it be at the beginning, middle, or ending of it.*

FOr the resolving this doubt, I look upon the Moon (if at Sea, where I cannot see the time of the Tyde) and I find she is increasing not far from the Sun, nor very near him, and therefore I'll guess the Moon to be seven days old, and the Epact this year is 23, and *July* being the fifth month, I adde these two together, (namely, the *Epact* and the *month* from *March*) and they make 28; to which if you adde the supposed Moons age seven days, it makes 35; from which

which ſubſtract 30 (becauſe it's above a whole Moon) the remainder is 5 for the day of the month; but by the Diſtick the 5th day of *July* ſhould be of a *Saturday*, and therefore *Munday* being two days after it, is the 7th day of the month. This, when your *Epact* and months from *March* be more than the ſuppoſed Moons Age.

CHAP. XXI.

How to Extract the Square and Cube Roots of any number, both by Arithmetick, and by the Table of Logarithms at the end of this Book.

I. *Of the Extraction of the* Square Root.

THe Square of any number is that number multiplied by it ſelf, as 4 multiplied by it ſelf is 16 (the Square of 4); and the Root of any number is the number it ſelf, as here 4 is the Root of 16. And it is requiſite that the young Sea-man or Gunner ſhould readily know the Squares of all the nine Digits; which this Table ſheweth.

Root	1	2	3	4	5	6	7	8	9
Square	1	4	9	16	25	36	49	64	81

Example 1.

Admit I would Extract the Square Root of 4096.

I ſet my number down, and draw a crooked Line for a Quotient, as you ſee here in the Margen, and prick the firſt figure from the Quotient, and every other. Now ſo many figures as there is pricks, will be the number of figures contained in the root of the given number.

4096 (
 . .

My ſum being thus fitted, I ask what is the greateſt Root in the firſt Square 40, and I conſider 6 is the neareſt leſs; for 6 times 6 is 36: (note, always to

take

take the neareſt leſs.) Set 6 in the Quotient, and 6 upon the prick, and ſay, (as in common Diviſion) 6 times 6 is 36 from 40, and the remainder is 4; daſh as you go, and the ſum will ſtand thus.

4
4 0 9 6 (6
6 ·

This done, double the Quotient for a new Diviſor, and the ſum ſtands thus.

4
4 0 9 6 (6
6 2 ·

Then (as in common Diviſion) ask how many times 1 you can have in 4; (but take this care that you take no more times than that ſo taken and ſet upon the next prick, and multiplied in it ſelf, (as well as the others by it) will be taken out of the remaining Diviſor:) and with this caution, do as in common Diviſion, and your ſum is done, and ſtands thus; 64 being the *Root*, and nothing remains.

1

(0
4 1 (0
4 0 9 6 (64
6 2 4
1

Example 2.

Admit I would extract the Square Root of

3 7 5 8 7 (
· · ·

(3
1 9 (3
2 9 4 4 (8
3 7 5 8 7 (193
1 2 9 8 3 193
3 ———
579
17378
1933
3
———
37587

First I ſet it in order, and proceed in the ſame manner as in the laſt Example, and the Root is 193, and a part of a unite above; but if you would prove whether this *Root* be extracted true, multiply the *Quotient* in it ſelf, and adde in the remainder of the Diviſion, and the Product will be the Dividend, as you may ſee in the Margen.

If you would extract the ſame Root to the tenth part of a unite, 'tis but adding two Cyphers to the Diviſor, with a little daſh between, and the Root will be as in the Margen, 193, 8; that is, 193 and 8 tenths of a unite. If you would have it done to the hundreth part of a unite, you muſt adde four Cyphers, and ſo you may come infinitely near, though not exactly to be done without ſome fraction, by the learneſt man living;

(2
3 (8
3 8 8
1 5 3 4 (5
2 9 4 4 8 2 (6
· ·
3 7 5 8 7, 0 0 (193, 8
1 2 9 8 3 8 8
3 8

and

and ſuch numbers as will not be extracted without leaving a remainder, are therefore called *Surd numbers*. Thus much for the *Square Root*.

II. *The Extraction of the* Cube-root.

THe Cube of any number is that number multiplied in it ſelf, and that Product multiplied by the ſame again. Thus, the Squar of 4 is 16; multiply 16 by 4, and it produceth 64, which is the *Cube* of 4: ſo 4 is the Cube-root of 64. The like is to be underſtood of any number elſe. But before you go forward, it will be convenient that you have the table of the Cube of every number, from 1 to 9, by heart; and therefore I have here inſerted them.

The Cube of	1	is	01	The Cube of	6	is	216
The Cube of	2	is	08	The Cube of	7	is	343
The Cube of	3	is	27	The Cube of	8	is	512
The Cube of	4	is	64	The Cube of	9	is	729
The Cube of	5	is	125				

Example 1.

Admit I would extract the Cube-root *off this number* 157464.

Firſt you are to underſtand that as you prick every ſecond figure when you extract the *Square Root*, ſo you muſt prick every *third figure* to extract the *Cube-root* of a number, thus: 157464 (And as many pricks as there is under the given number, ſo many figures will be in the *Cube-root* of your number, (as in this caſe two figures.)

But to proceed: Having ſet my ſum in order thus, and having the preceding Table by heart, I demand the greateſt Cube in the firſt Cube-number 157, and I find the greateſt (leſs) is 5: I ſet 5 in the Quotient, and cube it, and it makes 125. Set 125, as in the Margen, and ſubſtract it from 157, and the remainder is 32; to which carry down your next *Cube* 464, and the number will ſtand thus, 32464; which I call the *Reſolvend*.

157464 (5
125
32464 *reſolvend.*

Then

Then ſquare the Quotient, and treble that Square, and it makes 75; alſo treble the Quotient, and it makes 15; ſet them down as in the Margen, and adde them together, and the ſum 765 is a new Diviſor, and ſtands (as there you may ſee.)

Now let the whole Reſolvend (except the figure next the Quotient) be accounted as a Dividend, and demand how many times 7 (of the Diviſor) you can have out of 32, (that is, his correſpondent part in the Dividend) and take as in common Diviſion (obſerving all cautions as you do there) and I find I can have 4 times 7; ſet 4 in the Quotient, and the ſum will ſtand as in the Margen.

Next, multiply the 75, which was the treble Square of 5, (in the Quotient, and was 75) by the 4 in the Quotient, and it makes 300; ſet it down as here you ſee, and the ſum ſtands as in the Margen.

This done, multiply the 4 in the Quotient in it ſelf, and it makes 16; and that by the treble of 5 (in the Quotient, which is 15) and it makes 240, and ſet it under 300, as in the Margen: alſo cube the 4 in the Quotient (which is 64) and ſet it under 240; and them ſums adde together (as in the Margen) and they produce 32464; which ſum ſubſtract from the *Reſolvend*, placing the remainder underneath, which will be 00000. Thus the work is finiſhed, and the Cube-root of 157464 is 54 juſt.

157464 (5
125
32464 *reſolvend*
75
15
765 *diviſor*

157464 (54
125
32494 *reſolvend*
75
15
765 *diviſor*

157464 (54
125
32464 *reſolvend*
75
15
765
300

157464 (54
125
32464 *reſolvend*
75
15
765
300
240
64
32464

¶ Now this is to be minded: If the ſum laſt which was ſubſtracted from the Reſolvend had been more than the Reſolvend, the Root is not extracted right, and it muſt be done again, for the Root is too much.

¶ For every *Cube* (which is known by the points or pricks) except the firſt, (which is fartheſt from the Quotient) a Reſolvend is to be ſet apart, by bringing the next *Cube* to the remainder. Alſo, as often as you have a new *Reſolvend*, ſo often you muſt have a new *Diviſor*, which is found thus: Adde the treble of all the Root in the Quotient,

Quotient to the treble of the *Square* of the ſame Root, after they are placed in that order as is ſhewed in the Work before wrought.

¶ The way of finding the firſt figure of the Root of any number, is onely uſed at firſt; but all the work afterward is uſed for finding every place (except the firſt in the Root.) Now theſe Notes I would have you carefully uſe for to guide you in your work.

Example 2.

Suppoſe I would Extract the Root of this number 8203248.

First, diſtinguiſh the Cubes by the pricks (as hath been ſhewed) and then demand what is the greateſt Cube in 8 (which is the firſt Cube-number) and I conſider 2 is. Set 2 in the Quotient, and then cube the Quotient, and it is 8; ſet 8 upon the prick, under 8, and ſubſtract it from 8, and ſet down the remainder underneath (which is 0); to that 0 bring down the next Cube, which is 203, and the Work will ſtand thus.

```
8203248 (
. . .
Sum in order.
8203248 (2
. . .
8
0203 reſolvend
```

Now this Work (as I ſay) is no more repeated in the whole Work. Draw a Line under the Reſolvend, and ſquare the Root in the Quotient (which is 4) and treble that Square, and it is 12: this I ſet down under the Reſolvend (ſo) that 2 (in the unites place) may ſtand under 2 in the Reſolvand. Again, treble the Root in the Quotient, and it makes 6; ſet it as you ſee in the Work, then adde them together, and they produce 126 for a new *Devizor*, and the Work ſtands thus.

```
. . .
8203248 (2
8
0203 reſolvend
12
 06
126 Devizor
```

Next, counting all the figures of the Reſolvend, except that furtheſt to the right hand, for a Dividend, I demand how often I can have the Devizor (which is 126) from the Reſolvend (excepting one figure to the right hand) and I find I cannot take it once, and therefore I ſet 0 in the Quotient, and becauſe the three numbers that ſhould have been produced (as in the firſt Example) by the multiplying of 0 by 0, comes to 0; the Re-

```
. . .
8203248 (20
8
0203 reſolvend
12
 06
126 devizor
 203248 reſolv.
```

 ſolvend

ſolvend continues the ſame it was before: therefore (drawing a Line under the Devizor) ſet down the ſame Reſolvend 203, and bring down the next Cube-number 248 and ſet to it, on the right hand; ſo you will have 203248 for a new Reſolvend, and the Work will ſtand thus.

Then I ſquare the Root 20, and it makes 400; I treble that Square, and it makes 1200. Set it down under the new Reſolvend, and as you ſee in the Work; then ſet the treble of the whole Root in the Quotient 20 (which is 60) underneath 1200 in the manner, as you ſee in the Work: (for the 0 is under the laſt figure but one to the right hand of the Reſolvend, and hath been ſo all along to every Reſolvend.) Adde them together for a new Devizor, and the ſum is 12060, and ſtands thus.

```
. . .
8203248 (20
8
0203 reſolvend
12
 06
126 devizor
203248 reſolv.
1200
  60
12060 devizor
```

Now counting the whole Reſolvend, excepting the laſt figure to the right hand, for a new Dividend, I demand how many times 1 (the left hand figure of the Devizor) I can have in 2; and though I can have twice one, I muſt not take it; for then in the concluſion the ſum will be more than the Reſolvend, which muſt not be; but I take 1, and write it in the Quotient, then multiplying 1200 by the figure laſt placed in the Quotient, the product is the ſame, becauſe it was but 1 that multiplied it: place it under the 1200, as you ſee; alſo multiply the treble Root 60 by the ſquare of the figure laſt placed in the Quotient 1, and it is (60) becauſe 1 neither multiplies nor divides, and ſet it under 1200, ſo as you ſee. Laſtly, cube the laſt figure in the Quotient, and ſet it under, as you ſee (the Cube of 1 is 1). Set it under the laſt, or right hand figure of the Reſolvend, and adde them all together, their ſum is 120601; which number ſubſtract from the Reſolvend 203248, and the remainder is 082647.

```
. . .
8203248 (201
8
0203 reſolvend
12
 06
126 devizor
203248 reſolv.
1200
  60
12060 devizor
1200
  60
   01
120601 ablati.
082647 remain.
```

Thus the Work is finiſhed, and I find the Cube-root of 8203248, is 201, and ſomething more, becauſe there remains 82647; but how much it is more, no man in the world can exactly tell, although it may be done infinitely near by adding ternaries of Cyphers, to wit, 000

to

to the number whoſe Root is to be found: one ternary will bring it to the tenth of a unite, two ternaries (thus, 000. 000) added will bring it to hundreds of a unite, *&c.* But this may ſuffice for the Arithmetical Extraction of the Cube-root.

But becauſe it ſeems intricate to do it this way, and indeed 'tis not common for Sea-men and Gunners to be ſo good Arithmetitians, (for whoſe ſake I write this) I ſhall here following ſhew a very eaſie way to extract both the *Square* and *Cube-root* by the Tables of *Logarithms.*

How to extract the Square Root of any number, by the Table of Logarithms.

IF you would ſquare any number, look for the Logarithm of that number, and double it: the number anſwering to that Logarithm is the *Square* required.

Example.

If I would know the Square of 5, the Logarithm is 0.69897
2

The double of that Logarithm is 1.39794
The number anſwering this is 25, the *Square* required.

'Tis evident then, that if you would extract the Square Root of any number, that if you take the half of his Logarithm, the number anſwering to that, is the Root of that number.

Example.

Let it be required to extract the Square root of 25.
I look for the Logarithm of 25, and it is 1.39794
The half of his Logarithm is 0.69897
Now the number anſwering this half is 5, the *Root* of the number required.

To Extract the Cube-root *by the Table of Logarithms.*

IF you would cube any number, look for the Logarithm of that number, and treble it; the Product ſhall be the Logarithm of the *Cube* of that number.

Example.

Let it be required to cube 5.
I look for the Logarithm of 5, and it is 0.69897
I multiply it by 3

And the Product is this Logarithm 2.09691

I look in the Tables, and find the number anſwering to this Logarithm is 125, the true Cube 5, which was required.

It is evident then, that if you would extract the *Cube-root* of a number, take the third of the Logarithm of that number, and it ſhall be the *Logarithm* of the *Root* required.

Example.

Let it be required to extract the Cube-root of 125.
I look for the Logarithm of 125, and it is 2.09691
One third of it is 0.69897

Againſt which you will find 5, which is the *Cube-root* of 125 required.

The like for any number whatſoever. This may be ſufficient for the Extraction of the Square and Cube.

CHAP. XXII.

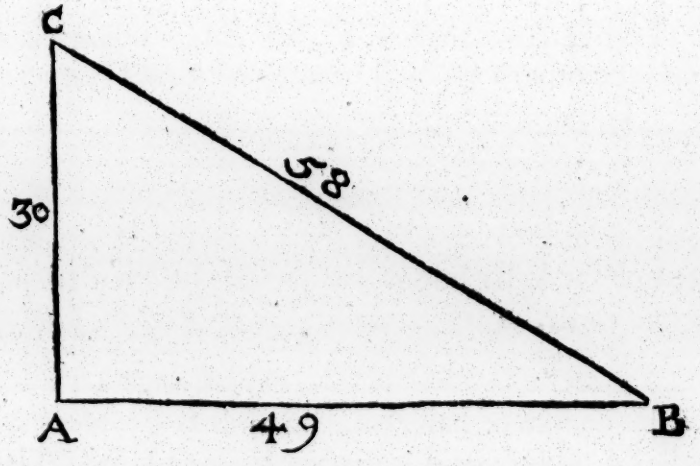
Some Cases *of a right angled Plain Triangle, performed by the Square Root.*

CASE 1.

Distance run, and difference of Latitude given, to find the Departure.

Quest. 1. Admit I ſail upon ſome point between the South and the Eaſt 58 leagues, I demand my *departure* from my *Meridian*, provided I have differed my Latitude 1 *deg.* 30′ or 30 leagues?

Note, *The Square of the longeſt ſide of any right lined right angled Triangle, is equal to the Square of the other two ſides.* Eucl. 1. *prop.* 47.



SO then if we ſquare the ſide C B 58 leagues, and afterwards ſquare the difference of Latitude C A 30, and ſubſtract it from the ſquare of C B, the remainder muſt be the ſquare of A B, the Meridian-diſtance; the Root of which number is the ſide A B.

Example.

Example.

Facit 49 for the side A B

A C 30
30
900

C B 58
58
464
290
The Square is 3364
900
The Square of A B 2464

Next, to find the Course.

We have now the *Meridian-distance* found to be 49 leagues, and the difference of Latitude A C 30 leagues is given.

$\sqrt{6}$
$8\sqrt{3}$
$2\sqrt{8}\sqrt{4}$
$4\ 8\ 9$

A General Rule.

Take half the length of the longest of the lesser sides, and adde it to the longest side, (which is the distance run) and say,

As that sum, is to the shortest side; so is this general number 86, *to the Angle opposite to that shortest side*; which (in this case) is B, the Complement of the Course to 90 degrees. (I have shewed in the Doctrine of Triangles, how the three Angles of any right lined Triangle contain but 180 degrees: then, if so, one Angle being 90 degrees, or a right Angle, the other two must be Complements one to another, as in this case.) To proceed:

Example.

The longest side is B C 58
The longest of the lesser side is A B 49; its half, omitting the half unite, is 25

Which together are 83

I say then, If the sum of half A B, and all B C 83, gives A C 30; What shall 86 give? And it gives 31 *deg.* 5′, which is the Angle at B, whose Complement to 90 deg. is the Angle of the Course C, 58 *deg.* 55′ to the Eastward of the South.

83 : 30 :: 86?

$\sqrt{}$
$\sqrt{9}(7$
$2\sqrt{5}8\ 0(31)$: 7
$8\ 3\ 3$ 60
8 420

30
2580
(5
$4\sqrt{8}0(5$
$8\ 3$

But

But you may ask how the 5′ comes out: you ſee the remainder of the firſt diviſion is 7; I multiply that by 60, and it gives 420; and that Product divided by the firſt Diviſor 83, gives the minutes that be contained in the fraction, which here is 5′.

CASE 2.

The diſtance run, and departure from the Meridian given, to find the Courſe and difference of Latitude.

Queſt. 2. *Let the departure from the Meridian be* 30 *miles, and the diſtance run* 54 *miles, I demand the Courſe and difference of Latitude, provided I ſailed between the North and the Weſt.*

IN this caſe, ſquare the diſtance run by it ſelf, and the departure from the Meridian by it ſelf, and ſubſtract the leſſer ſquare from the greater, and the remainder is the ſquare of the difference of Latitude; becauſe the ſquare of the longeſt ſide is equal to the ſquares of both the other two (as hath been ſhewed); the Root of which is the difference of Latitude required.

Example, for the difference of Latitude.

	30	54		
	30	54		
The Square of the Departure	900	216	(8	
		270	484(0	
			2816(44	the diff. of
The Square of the difference		2916	484	Latitude.
		900		
The Square of the difference of Latitude		2016		

For the Courſe.

I take half the length of the longeſt of the leſſer ſides, and the longeſt ſide, and adde them together, and ſay, If that ſum (which is 76) gives the leaſt ſide 30, what ſhall 86 give, and it gives in this Example 32 *deg.* 36′, which is the Angle of the Courſe, becauſe it's againſt the ſhorteſt ſide, which is the departure.

CASE

CASE 3.

Difference of Latitude and Departure given, to find the Courſe and diſtance.

Queſt. 3. *Let the difference of Latitude be 60 miles, the Departure 38 miles, I demand the Courſe and diſtance run.*

First, *For the Diſtance.*

I Conſider the ſquare of the difference of Latitude, and the ſquare of the Departure, are equal to the ſquare of the diſtance run; therefore ſquare them ſeverally, and adde their ſquares together, and that ſum is the ſquare of the diſtance run, the root of which, is the length of that ſide.

Example.	60	38
	60	38
The difference of Latitude ſquared is	3600	304
The Meridian-diſtance ſquared is	1444	114
The ſum is the ſquare of the diſtance	5044	1444

The Root of which number is 71, the diſtance in miles required.

x (3
5044 (71
7 4 x
x

Secondly, *For the Courſe.*

I take (as before) the longeſt of the leſſer ſides, and adde the half of it to the diſtance run, and it makes 101.

I ſay then, If 101 gives 38, what ſhall 86 give? I multiply and divide, and find 32 for the Quotient, and 36 for the remainder; which is 32 *deg.* 21′, the Courſe made good. The like of any other of this kind.

CHAP.

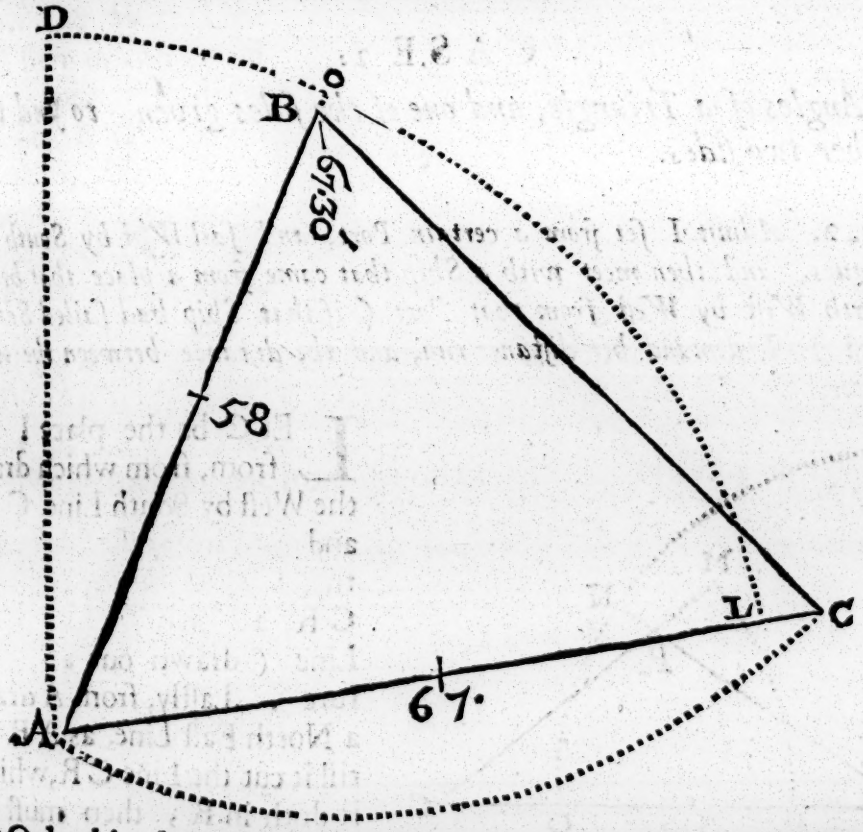
CHAP. XXIII.

Some Cases of Oblique angled Triangles, performed by the Plain Scale.

CASE I.

Two sides, with an Angle opposite to one of them given, to find the other Angles, and the side.

Quest. 1. *Admit there be two Ships set from one Port, one sails North North East 58 leagues, the other sails 67 leagues, and at the end of her sailing the first Ship bears from her North West; I demand their distance asunder, and the second Ships Course?*



TO do this, draw the North and South Line A D; and making A the place of your Ships setting out, set off a North North East

 Course

Course from A (which is the first Ships rumb) and upon it set off her distance run 58 leagues, which reacheth from A to B: then from B, as a center, describe the Arch A C, and from A, towards C, set off six points, and draw the Line B C, which is a South East Course from B, or from C to B is a North West Course, according to the Question. Lastly, take the second Ships distance run 69 leagues, and fixing one foot in A, where the other foot of your Compasses cuts the North West and South East Line B C, there must your second Ship be (which is at C); and this is evident, because C B cuts the first, and is a North West Line from the second, as the Question gives it.

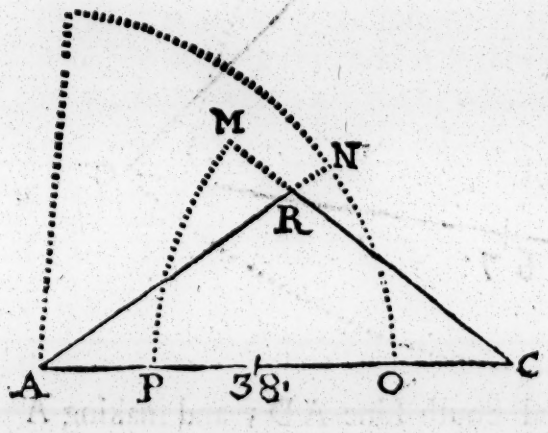
Measure the side C B, and it's the distance of the Ships one from the other, 62 ½ leagues.

Measure the Angle at A, whose measure is O C, and is so many degrees or points to the Eastwards of the North, North East (the first Ships Course) it makes; I find it here to be North North East 5 *deg.* 30′ Easterly, or East 8 degrees Northerly. The like for any other of this nature.

CASE 2.

The Angles of a Triangle, and one of the sides given, to find the other two sides.

Quest. 2. *Admit I set from a certain Port, and sail West by South 38 leagues, and then meet with a Ship that came from a place that bears North West by West from that Port (if that Ship had sailed South West) I demand her distance run, and the distance between the two places.*



LEt C be the place I set from, from which draw the West by South Line C A, and upon it set off 38 leagues; then from C set off the Line C R, a North West by West Line (drawn out at pleasure). Lastly, from A draw a North East Line, as A R is, till it cut the Line C R, which it doth in R; then must R C be the distance between the two Ports; and R A the second

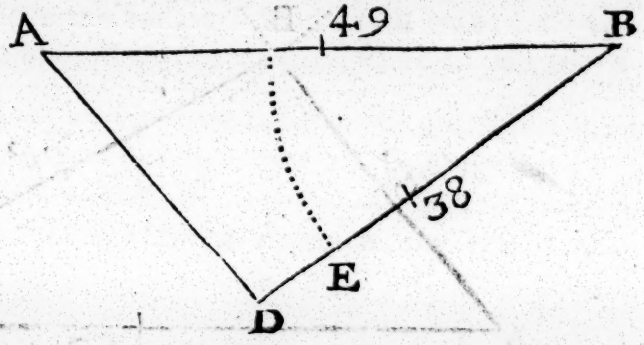
ſecond Ships diſtance run, becauſe 'tis a South Weſt Line from R, to the place where the Ships meet.

The diſtance between the places R C is 21 *leagues* ½
The ſecond Ships diſtance run R A is 27 *leagues* ½

CASE 3.

Two ſides and the contained Angle given, to find the third ſide and the other Angles.

Queſt. 3. *Admit there be two Ships ſet from one Port, one ſails South Weſt by Weſt 38 leagues, the other ſails Weſt 49 leagues; I demand the diſtance between theſe Ships at the end of their ſailing, and their bearing one from the other.*



SUppoſe B to be the place I ſet from; draw the Weſt Line B A from it, and ſet off 49 leagues, alſo draw the Line B D a South Weſt by Weſt Line, from B, and ſet off 38 *leagues* upon that which reacheth to D, draw your ſide D A, and ſo you have the Triangle A B D. Take off A D, and ſee what it is: And becauſe A B is an Eaſt Line from A, by an Arch of 60 degrees, ſee how many points to the Southwards of the Eaſt, the Line A D runs, which is their bearing one from the other.

The Ships bear one from the other N W by N 5 *d.* Wſtly. or its contrary.

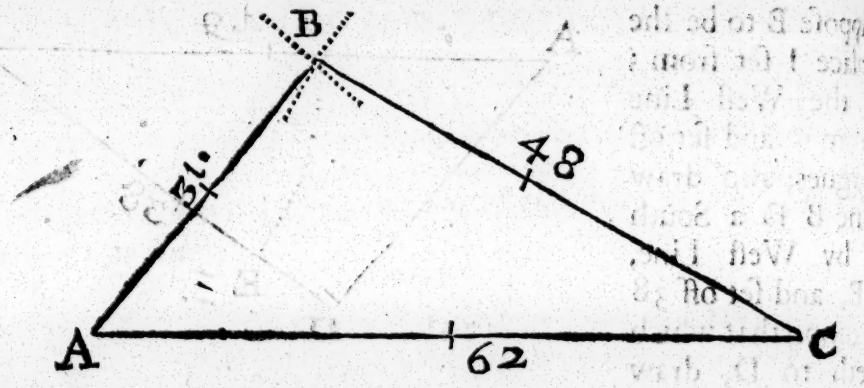
They be diſtant from one another 27 *leagues* ½

CASE 4.

The three sides of a Triangle given, to find the Angles.

Queſt. 4. *There be two Ports in one Latitude, diſtant 62 leagues; a Ship ſet from the Eaſtermoſt of theſe Ports, and ſailed upon ſome point between the North and the Weſt 48 leagues, and then meets with a Ship that had ſailed from the Weſtermoſt of theſe Ports 31 leagues: I demand each Ships Courſe.*

DRaw the Eaſt and Weſt Line A C, and from C ſet off 62 leagues on it, which reacheth to A; next, take the Eaſtermoſt Ships diſtance run 48 leagues, and upon C, as a center, deſcribe the Arch S.



Laſtly, take the Weſtermoſt Ships diſtance run, and ſet it from A, and where it cuts the Arch S which is at B, there the Ships muſt needs meet. You may meaſure the Angles of their Courſe, from your firſt Eaſt and Weſt Line A C.

The Eaſtermoſt Ship ſailed Weſt 29 *deg.* 20′ Northerly.
The Weſtermoſt Ship ſailed Eaſt 46 *deg.* Northerly.

Thus much for Oblique Triangles by the Plain Scale.

CHAP. XXIV.

Propoſitions of Sailing by Mercator's *Chard, performed by the Plain Scale.*

I Have ſhewed before how to keep a Reckoning by Plano, and alſo by the plain Scale of Longitude how to reduce that Reckoning into *Mercator*'s Projection every day; and have alſo handled the Caſes of Right angled and Oblique angled Triangles by the Plain Scale.

I come now to ſhew the Caſes of a right angled Triangle, performed by the Plain Scale in *Mercator*'s Sailing; which will more fully ſatisfie you how that Reckoning is converted from *Plain* to *Mercator*'s Projection.

PROB. I.

To find the Meridional parts contained between any two Latitudes.

Queſt. 1. *Admit I would know the Meridional parts contained between the Latitudes of* 51 deg. 10′, *and* 48 deg. 00′.

FIrſt, take the middle Latitude between theſe two Latitudes, which is done by ſubſtracting the leſſer Latitude from the greater; and half that difference adde to the leſſer Latitude, and it gives the *middle Latitude*: (or if it be ſubſtracted from the greater Latitude, it doth the ſame thing.)

I find the middle Latitude here to be 49 *deg.* 35′.

Next, ſee how many miles goes to make a degree of *Longitude* in that middle Latitude, which I find to be 39 miles (neareſt); then convert your whole difference of Latitude into miles, and it makes 190 miles or minutes, (for all minutes of Latitude are miles:) Then ſay by the Rule of Three, If 39 miles gives 60′ (or Meridional parts) what ſhall 190 miles give?

	′		(1
			3 8 3
39	60	190	5 8 8 (2
		60	x x 4 8 8 (292
			3 8 8 8
Facit 292 Meridional		11400	3 3
Parts and $\frac{11}{39}$ of a part			

So I conclude, that 292 is the Meridional parts contained in the difference of Latitude. I have ſhewed before how to find the number of miles in any Parallel that goeth to a degree of Longitude, by the Plain Scale of Chords, and Line of Longitude, and therefore omit it here.

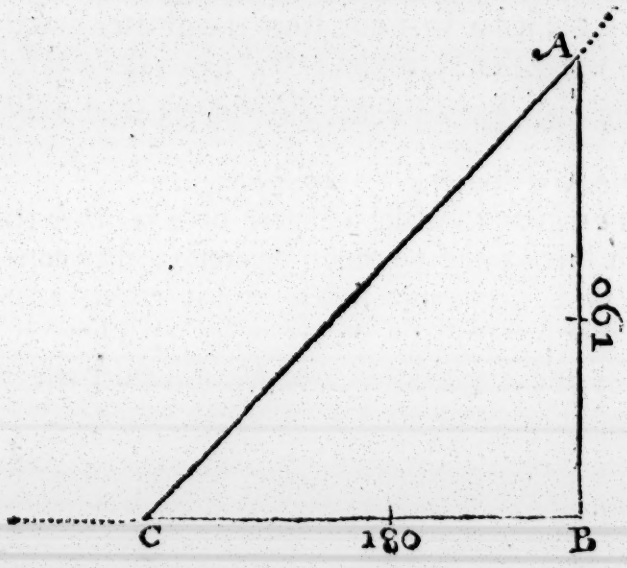
PROB. II.

The Latitudes of two places, with the difference of Longitude given, to find their diſtance and Rumb.

Queſt. 2. *Admit there be two places, the one in North Latitude* 51 deg. 10′, *the other in North Latitude* 48 deg. 00′, *and to the Weſtward of the Meridian of the Northermoſt* 4 deg. 38′; *I demand their diſtance in miles, and their bearing one from the other.*

TO anſwer this Queſtion; take the middle Latitude, and reduce the difference of Longitude into miles (as was ſhewed in the firſt Problem:) alſo reduce the whole difference of Latitude into miles, then have you the difference of *Latitude*, and the difference of *Longitude* given, to find the *Courſe* and *Departure*, you may protract it, as hath been ſhewed in a Caſe of that kind already.

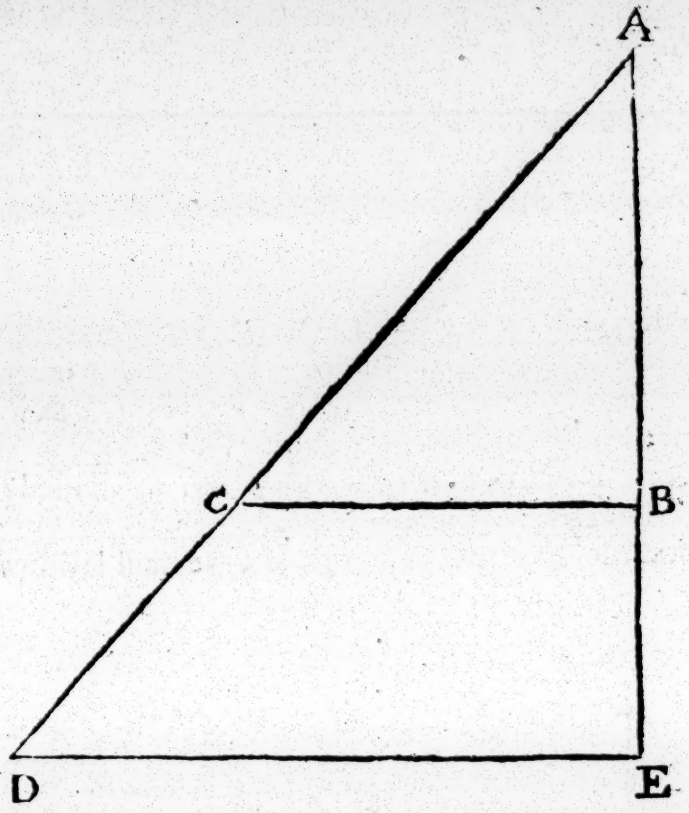
The difference of Latitude, reduced into miles, is 190 *miles*.
The difference of Longitude, reduced into miles, is 180 *miles*.



The Triangle that is made with that difference of Latitude and Meridian diſtance, is C A B; take off the diſtance A C, and the Angle of the Courſe at A, as is ſhewed. I find the diſtance A C is 26[illegible] miles. The Courſe is from the Northermoſt Port South 43 *deg.* 3[illegible] Wetterly.

B[illegible]

But this might have been protracted by the difference of Longitude given *Mercator*'s way. First, thus: See what Meridional parts are contained between the two Latitudes (as hath been shewed *Prob.* 1.)



and I find 292 parts; with this and my difference of Longitude in parts I lay down the Triangle A D E, as if the parts were miles, and find the Course at A, as before, to be 43 *deg.* 30′, to the Westwards of the South, leading to D. This done, I see what my difference of Latitude in miles is, and from A, I set it off to B, and draw the Line B C parallel to D E, and it cuts the rainge of the Course in C: so then A is the distance in miles between the places; and A is the Angle of the Course common to both the Triangles, and the same as before it was found to be.

PROB.

PROB. III.

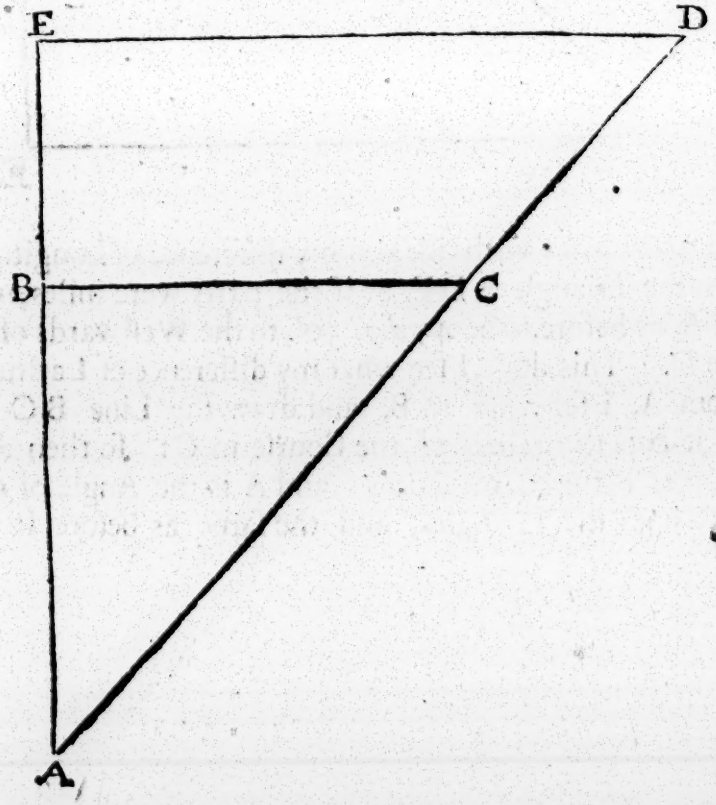
The Latitudes of two places, and the distance between them given, to find the Course that leads from one to the other, and the difference of Longitude between them.

Quest. 3. *Admit there be a place in the Latitude of* 48 deg. *and another in the Latitude of* 51 deg. 10′, *and to the Eastward of the former (distant* 260 *miles) ; I demand their* bearing *and* difference of Longitude.

IN this case you have the two Latitudes given, and the distance; so that with the difference of Latitude reduced into miles, and the distance; you may lay down the Triangle A C B (as is shewed) and find the Course, as in a common Question.

The Course is North East by North, 9 *deg.* 45′ Easterly ; or North 43 *deg.* 30′ Easterly.

But to find the difference of Longitude, we must lay down the Angle thus.



Find

Find the difference of Latitude in Meridional parts, and ſet it off upon the North and South Line from A, and it reacheth to E; from E raiſe a perpendicular or Eaſt Line, and where the Line A C (extended) meets with that Line, which is at D; there the Ship will be, (by accounting the ſides in parts, ſuch as 60′ makes a degree of Longitude); meaſure the ſide E D, and divide it by 60, and your Queſtion is anſwered.

The difference of Longitude is E D 278 parts, or 4 *deg.* 38′.

And this is evident: for,

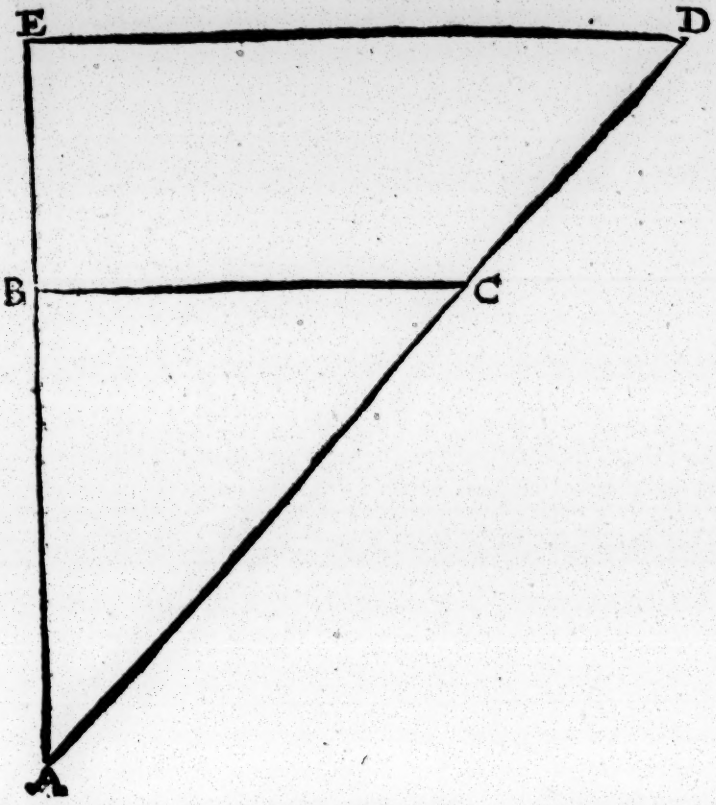
As A B, the difference of Latitude in miles,
Is to A E, the difference of Latitude in Meridional parts;
So is B C, the Meridian-diſtance,
To E D, the difference of Longitude in parts, ſuch as 60 is 1 *deg.*

PROB. IV.

The Courſe or Rumb, and the Latitude of two places given, to find the diſtance and difference of Longitude between them.

Queſt. 4. *Admit there be a place in the Latitude of* 51 deg. 10′, *another in the Latitude of* 48 deg. 00′. *Now the Northermoſt of theſe places bears from the Southermoſt, North* 43 deg. 30′ *Eaſterly: I demand the* diſtance *of theſe places, and the* difference of Longitude *between them?*

TO lay down this Queſtion, ſubſtract the Latitudes one from the other, and ſo I have the difference of Latitude 3 *deg.* 10′, or 190 miles. With that and the Courſe given (in the Queſtion) I lay down the Triangle A B C (as is ſhewed before.) This done, find the middle Latitude (as before hath been ſhewed) it's 49 *deg.* 35′; and next, the Meridional parts contained between the two Latitudes, which is 292 parts. Theſe Meridional parts I uſe to ſet off the difference of Latitude in the ſecond Triangle, as I did the difference



of Latitude in miles in the firſt Triangle; and ſetting it from A, it reacheth to E; from E then draw the Line E D parallel to B C, till it concur in the diſtance run, which is at D, then reſolve the Queſtion.

A C is the diſtance run in miles, 260 *miles.*

E D is the difference of Longitude in minutes, 278 *min.* or 4 *d.* 38'.

Take them off, and you will find them to be ſo upon the Scale of equal parts.

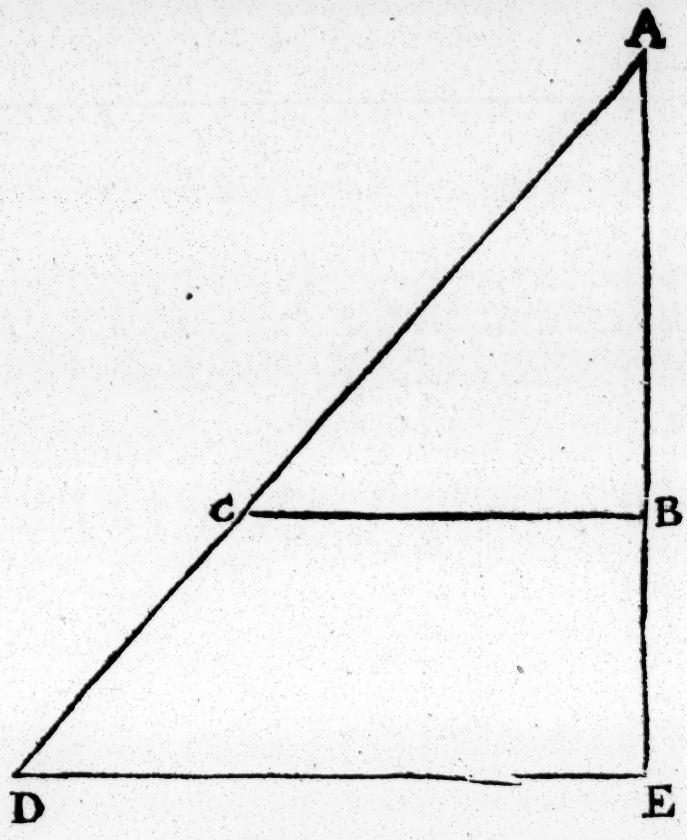
Prob. V.

The Rumb, or Courſe between two places, and the difference of Longitude, with one Latitude given, to find the others Latitude, and the diſtance between them.

Queſt. 5. *Admit I ſet from* Lunde *(which is in the Latitude of* 51 deg. 10') *and ſail till I have Weſt Longitude from it* 4 deg. 38', *and that then I bear from it Weſt* 46 deg. 30' *Southerly; I demand my* diſtance *from it, and what* Latitude *I am in?*

For the laying down this Queſtion, I convert my difference of Longitude given into minutes or parts, by multiplying the degrees by

by 60, and adding in the odde 28′, and it is 278′. By the Course given me in the Question, and this difference of Longitude in minutes,



I lay down the Triangle A E D, as any common Triangle is laid down, that hath the Course and Meridian-distance given, using the difference of Longitude, as if it were Meridian-distance: This done, I see how many Meridional parts the difference of Latitude A E is, and I find it here to be 292. And thus you have the Meridional parts contained between the two Latitudes.

But now to find the other Latitude, you are to consider, you know not what number of miles is contained in this difference of Latitude in parts found, because you know not the middle Latitude; therefore we'll proceed thus to find the other Latitude: I see by my Scale of Longitude how many miles goes to a degree in the Latitude that's given me, (which is 51 *deg.* 10′) and I find 38 miles (neareſt.) I ſay then, If 60 Meridional parts of Latitude gives 38 miles; What ſhall the Meridional parts contained between the two Latitudes 292 give?

60 : 38 :: 292
38

Facit 185 miles lacking four *seconds* or 3 *deg.* 4′ ⅝ of Latitude.

2336
876

11096

This 3 *deg.* 5′ of Latitude, subſtracted from the given Latitude 51 *deg.* 10′ leaves for the other Latitude 48 *deg.* 5′, which is too much Northerly. But let it ſtand.

We will next ſee how many miles makes a degree in this Latitude found 48 *deg.* 5′, and it gives 40 miles. I ſay then, If 60 Meridional parts of Latitude, gives 40 miles; What ſhall the Meridional parts contained between the two Latitudes 292 parts, give?

60 : 40 :: 292
40

Facit 194⅔ miles, or 3 *deg.* 14′---40″

11680

This then makes the difference of Latitude to be 3 *deg.* 15′ (nearest) ſo that the other Latitude then ſhould be 47 *deg.* 55′, which is as much too little, as the other before found was too much: Wherefore the half difference between the two Latitudes thus found, which is 5′, added to the leſſer, gives the true Latitude required, 48 *deg.* 00′; or ſubſtracted from the greater, which was 48 *deg.* 5′, gives the ſame thing, namely 48 *deg.* 00′. The like for any other Queſtion of this nature. The reaſon of this is evident, as appears by the very working of it, by the two extream Latitudes.

The other Latitude being found, I ſubſtract them one from the other, and the remainder is the difference of Latitude, which is 3 *deg.* 10′, or 190 miles.

Thus then I have the Courſe in the Queſtion given me, and the difference of Latitude in miles, whereby I may lay down the little Triangle A B C, (as is ſhewed) and take off the ſide A C, and meaſure it.

The Ship is diſtant from *Lunde*, or A C is 260 miles.

PROB.

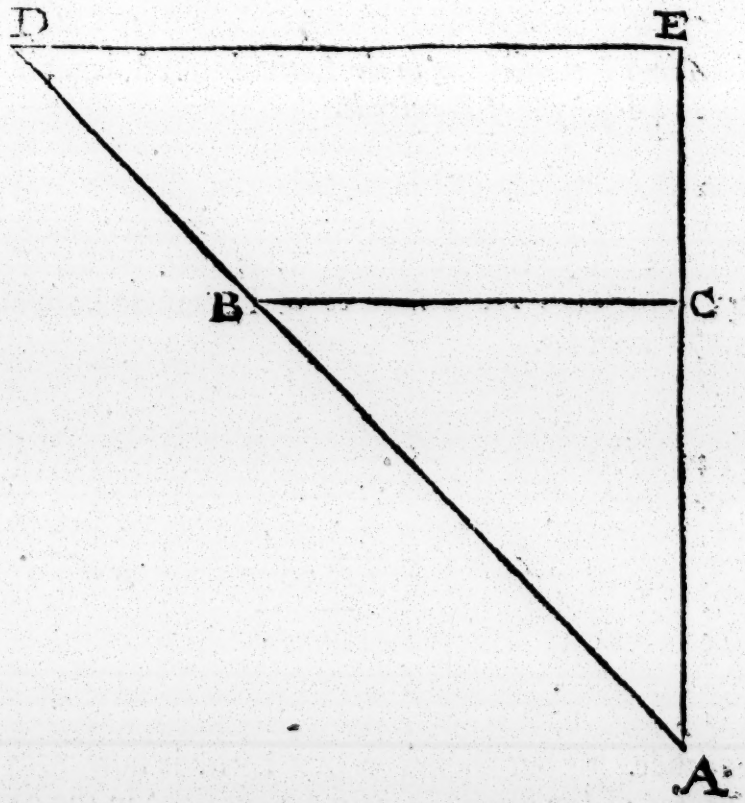
PROB. VI.

The Course, the distance, and one Latitude given, to find the other Latitude, and the difference of Longitude.

Quest. 6. *Admit there be a place in the Latitude of* 48 deg. 00′ *Northerly, and I sail from it North West by North* 9 deg. 45′ *Westerly, (which is North* 43 deg. 30′ *Westerly)* 260 *miles; I demand what Latitude I am in, and my difference of Longitude.*

TO resolve this Question, I lay down the Triangle A B C, as hath been shewed before in an Example of that nature, and see what your difference of Latitude C A is in miles; I find it here to be 190 miles, and the Meridian-distance is B C 180 miles.

Now this 190 miles divided by 60, gives the difference of Latitude in degrees and minutes (which is 3 *deg.* 10′) that added to the Latitude, I set from 48 *deg.* 00′, gives the Latitude I am now in, namely 51 *deg.* 10′ (which was required.)



Next,

Next, to find the difference of Longitude; I take the half of 3 *deg.* 10′, and ſubſtract it from the greateſt Latitude found (or adde it to the leſſer given) and you have the middle Latitude 49 *deg.* 35′; then ſee how many miles goeth to a degree of Longitude in that Latitude, and I find 38 miles. I ſay then, (to find the Meridional parts contained between the two Latitudes) If 38 miles gives 60 minutes, or parts; What ſhall the difference of Latitude in miles give, being 190 miles? I multiply and divide, and find it gives 292 parts.

Take this 292, and with it and the Courſe lay down the Triangle A E D, uſing the difference of Latitude in parts, as though they were miles, and ſo they will reach from A to E; from E raiſe a Perpendicular, and draw it out till it cuts the diſtance A B extended in D: Laſtly, take off the difference of Longitude D E, and ſee how many minutes it is.

I find the difference of Longitude D E to be 278′ or 4 *deg.* 38′.

Prob. VII.

To convert any number of miles into minutes of Longitude, or minutes of Longitude into miles, in any Latitude.

Queſt. 7. *Admit I would know in the Latitude of* 28 deg. 30′, *how many miles is in* 4 deg. 38′ *of Longitude.*

REduce the difference of Longitude given into minutes, and ſee how many miles goeth to a degree in the given Latitude, which I find in this Caſe 53 miles doth it. I ſay then, If 60 minutes gives 53 miles; What ſhall the difference of Longitude in minutes give? which is 278 minutes.

60 : 53 :: 278

53

834

1390

14734

Facit 245 miles, and 34″ of a mile

xx

x47[34(245

6660

If you have occaſion to put miles into minutes, or Meridional parts, in any Latitude, 'tis but finding in that Latitude how many miles goeth to a degree of Longitude, (as we have done in the Example before,

fore 53) and ſay, If 53 miles gives 60 minutes; What ſhall the Departure 245 miles give? Multiply and divide.

53 : 60 :: 245
60
14700

3(2
64
x9(9
x47oo(277
3333
55

Facit 277 $\frac{29}{53}$, which is near 278, and would have been ſo exactly, if I had not neglected the fraction of the firſt number of miles found; but I have treated of this before, and alſo ſhewed how to keep a Reckoning by this way of Sailing, to which I refer you for both. And thus you ſee all the Caſes of Sailing by *Mercator*'s Chart may be exactly reſolved by the Plain Scale.

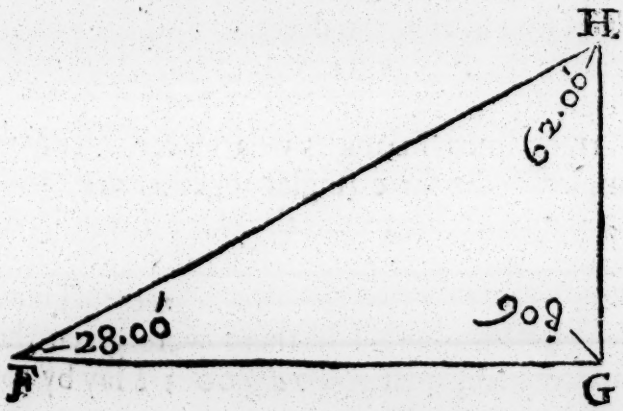
Before we proceed to the Doctrine of Right lined Triangles, it will be neceſſary to inſert (in this place) ſome *Trigonometrical Definitions.*

CHAP. XXV.

Trigonometrical Definitions.

Defin. 1. A Triangle is a Figure conſiſting of three ſides, and as many Angles, as is the Triangle H G F.

2. Any two ſides of a Triangle, are called the ſides of the Angle including between them, as the ſides H F and G F are the ſides containing the Angle H F G.



3. The

3. The measure of an Angle is the quantity of the Arch of a Circle described upon the angular point and cutting both the sides containing the Angle.

4. A Degree is the 360 part of any Circle. Therefore,

5. A Semi-circle contains 180 degrees. And,

6. A Quadrant (or right Angle) contains 90 degrees.

7. The Complement of an Angle less than 90 degrees, is so much as that Angle wanteth of 90 degrees.

8. The Complement of an Angle to a Semi-circle, is so much as that Angle wanteth of 180 degrees.

9. An Angle is either Right, Acute, or Obtuse.

10. A Right Angle is that whose measure is 90 degrees, or a Quadrant.

11. An Acute Angle is less than a Right Angle, and always contains less than 90 degrees.

12. An Obtuse Angle is greater than a Right Angle, and always contains more than 90 degrees.

13. A Triangle is either right angled, or oblique angled.

14. A right angled Triangle, is such a Triangle as hath one Right Angle, as the figure H G F hath one Right Angle, namely that at G, which containeth just 90 degrees.

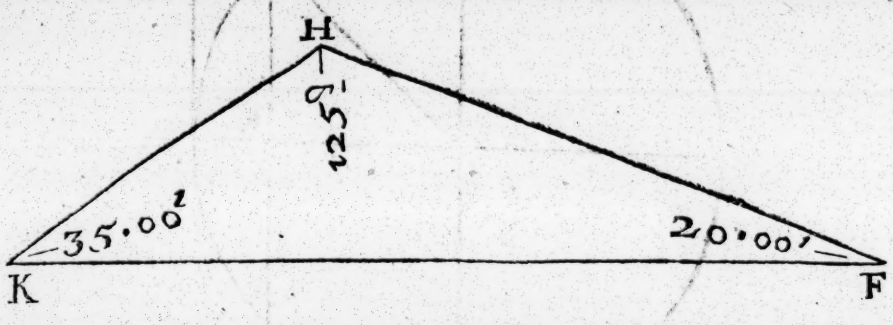
15. In every right angled Triangle, that side which subtendeth (or lieth opposite to) the Right Angle is called the *Hypotenuse*; and the other two sides, the one is called the *Perpendicular*, and the other the *Base*, at pleasure: but most commonly the shorter side is called the Perpendicular, and the longer side the Base. Thus the Triangle HFG the Hypotenuse is H F, the Perpendicular H G, and the Base F G.

16. In every right angled Triangle, if you have one of the Acute Angles given, the other is also given, it being the Complement thereof to 90 degrees, as in the Triangle H F G. If you have the Angle at H 62 degrees given, you have also the Angle at F given, it being the Complement of that at H to 90 degrees. Wherefore take 62 degrees from 90 degrees, and there will remain 28 *deg.* 00′, which is the quantity of the Angle F.

17. In all right lined Triangles whatsoever, (either right angled or oblique angled) the three Angles together are equal to two Right Angles, or contain 180 degrees: therefore if you have any two Angles of a Triangle given, you have also the third given, it being the Complement of the other two, to 180 degrees: Thus, in the Triangle H K F (as in this figure) if there were given the Angle HKF 35 *deg.*00′, and the Angle HFK 20 *deg.*00′; I say by consequence you

35 *deg.*

have the third Angle K H F alſo given, being the Complement of the other two to 180 degrees: for the two given Angles H K F 35 *deg.* 00′, and H F K 20 *deg.* 00′, being added together, make 55 *deg.* 00′; which being taken from 180, remains 125 *deg.* for the Angle K H F.



18. In all Triangles whatſoever, the ſides are in proportion one to the other, as the ſines of the Angles oppoſite to thoſe ſides: ſo in the Triangle *HKF*, the ſine of the Angle at K is in proportion to the ſide H F, which is oppoſite to it, as the ſine of the Angle at F is to the ſide H K, or the Angle at H to the ſide F K.

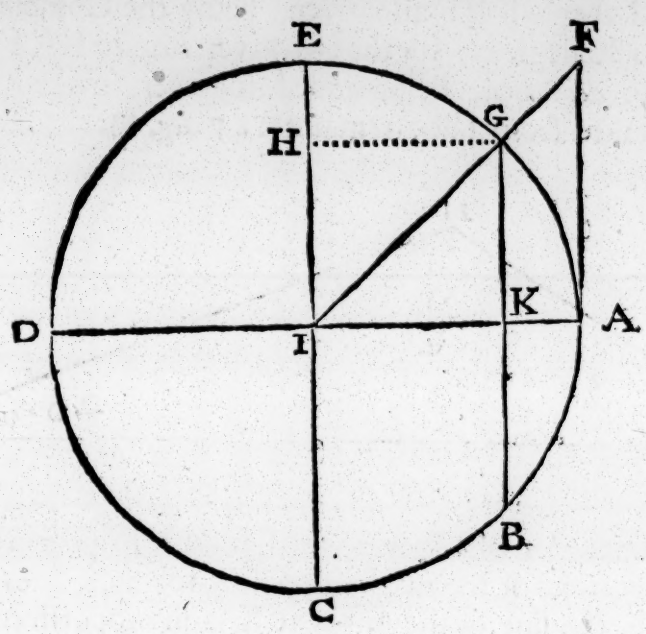
Theſe things I thought neceſſary to give ſome general hints of in this place. And now we will proceed to

CHAP. XXVI.

Of the Doctrine of right angled right lined Triangles.

HItherto we have ſhewed the Reſolution of the ſeveral Caſes of a right lined Triangle by the *Plain Scale* onely, and given you ſome *Trigonometrical Definitions*; but now we will proceed to handle the ſame things, and reſolve them by the Tables of *Sines*, *Tangents*, and *Logarithms*; and by *Gunter's Rule*.

If you look back, you may there ſee the projection of the Plain Scale, how it's deduced from a Circle, both the *Sines*, *Tangents*, and *Chords*; but for our preſent purpoſe, it will be neceſſary to ſhew the Projection of thoſe Lines more diſtinctly; which is done in the Figure following.



1. The *Sine* of an Arch, is a Line let fall perpendicularly from the Arch, to that other side that goeth from the center of the same Arch; as G K, is the *Sine* of the Angle at I, or the measure of it; or the *Sine* of the Arch G A, because I G is the *Radius* of the Circle, or the *Semi-diameter* of the Circle, or the *whole Sine*.

2. The *Chord* of an Arch, is a Line that goeth from one side to the other of a Circle, like the string of a Bow; as G B is the *Chord* of the Arch G A B. And here you may note, that *The right Sine of an Arch is half the Chord of twice that Arch*, as G K is the *Sine* of the Arch G A, and G K B is the Chord of the Arch G A B, which is twice that Arch.

3. The *Tangent* of an Arch, is a Perpendicular raised from the *Radius* of that Arch without the Circle, and concurring with another Line that goeth from its center; as A F is the *Tangent* of the Arch G A, or the measure of the Angle at I.

A General Rule.

And from hence its evident, *That in a* Triangle, *any of the three sides may be put as* Radius, *or the* Semi-diameter *of the Circle, or the* whole Sine; *and the other sides shall be as* Sines, Tangents, *or* Secants, *by them represented*; as we shall more fully shew by and by, and it's plain in the Projection of the *Plain Scale*.

Now the same proportion that the side put for *Radius* has to *Radius*, the same hath the other sides to the *Sines*, *Tangents*, or *Secant* by them represented.

4. The

4. The *Secant* of an Arch, is the longeſt ſide of a Triangle, or a Line drawn from the center, till it cuts the *Tangent*-line of that Arch; as I F is the *Secant* of the Angle at I.

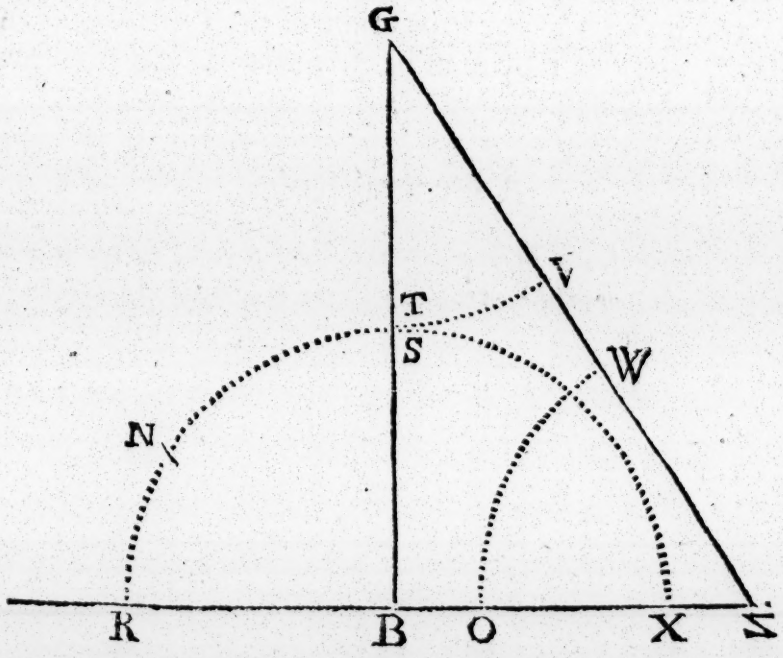
5. The *Verſed Sine* of an Arch, is that Line which is between the place where the right *Sine* falls, and the circumference; as K A is the *Verſed Sine* of the Arch G A.

Note, *That the* Sine *of any Arch leſs than* 90 deg. *is alſo the* Sine *of an Arch as much greater than* 90 deg. *as* G K *is the* Sine *of the Arch* G A. *Now* G A *is leſs than* 90 deg. *by the Arch* G E, *and is alſo the* Sine *of the Arch* G E D, *which is more than* 90 deg. *by the ſame Arch* E G.

I infer from hence then, That if an Angle or Arch be above 90 *deg.* if you take the *Sine* of what that wants of 180 degrees, it's the ſame thing: for it's the Complement of it to 180 degrees; and one *Sine* you ſee ſerves for both.

6. The *Complement* of an Arch leſs than 90 degrees, is what that Arch or Angle wants of 90 degrees; but if that Arch or Angle be above 90 degrees, the *Complement* of it is what it wants of 180 degrees, or a Semi-circle.

7. The three Angles of any *right lined Triangle*, conſiſts of no more nor leſs than a Semi-circle, or 180 degrees, as appears in this Figure following; in which you muſt own, that R S X is a Semi-circle. Now



if the Arches O W and V T, have the same diameter that the Arch X S N R hath; then if you take W O and set it from S, it reacheth N (it's the measure of the Angle at Z;) and take V T and set it from N, and it reacheth to R (it's the measure of the Angle at G:) so you see that all the three Angles reacheth from X to S, from S to N, and from N to R, and make a just Semi-circle, or 180 *deg.* X S N R, which was to be proved.

From hence I'll conclude then, that in any right lined right angled Triangle, if one of the Angles besides the Right Angle be known, the other Angle is known also; for it's that Angles Complement to 90 degrees.

I have said, that any of the three sides may be put as *Radius*, and the other sides shall be as *Sines*, *Tangents*, or *Secants*, by them represented.

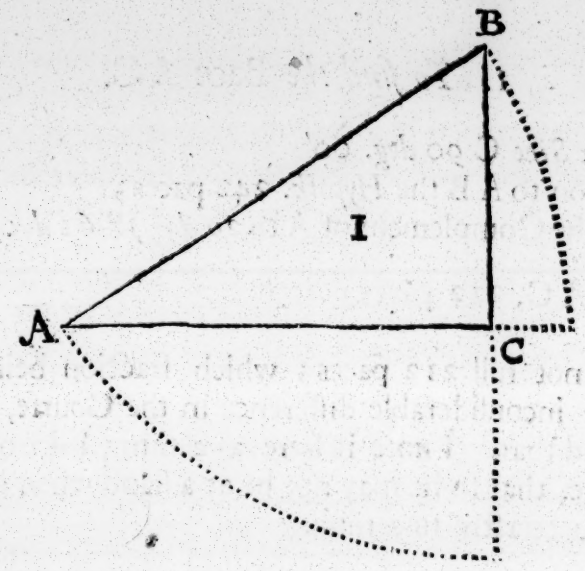
From what hath been said in the Projection of the *Plain Scale*, this appears: That in the Triangle A C B, if A B be the Semi-diameter of the Circle that the Scale be made by; then is B C the measure of the *Sine* of the Angle opposite to it (namely A) or equal to it: and for the same reason is A C the *Sine* of the Angle opposite to it at B, or equal to it, (for it's the measure of the *Sine* of it:) from whence it's evident, that if these sides measure the Angles, or be equal to them, they must be proportional one to the other.

Also, the side A B is the *Sine* of the Right Angle at C; for it's the *Radius* or the *whole Sine* of the Circle which the Scale is made by. And this you may see in the Projection of the *Plain Scale*. And now I say, if they be *equal*, they must be *proportional*. So that from hence will arise this *Conclusion*.

A General Rule.

That in all right lined Triangles, the Sine *of every* Angle *is proportional to his opposite* side, *or the contrary: Every* side *is proportional to the* Sine *of his opposite* Angle.

So



So then, as *Radius* or *Sine* C,
Is to B A, his oppoſite ſide;
So is *Sine* B,
In proportion to A C, his oppoſite ſide;
And ſo is *Sine* A to his oppoſite ſide B C,
Or the Converſe.

As B A,
Is in proportion to *Radius*, or *Sine* C 90 degrees;
So is A C,
In proportion to the *Sine* of his oppoſite Angle at B;
And ſo is B C to the *Sine* of his oppoſite Angle at A.

Theſe things premiſed, we'll make uſe of this general Rule as far as we can; and proceed to work the CASES.

CASE the firſt and ſecond.

The Hypothinuſe (*which is the longeſt ſide*) *and the* Angle *at the* Bace (*namely the Angle at* A *given*); *to find the* Bace *and the* Perpendicular.

LEt the *ſide* A B be 242 paces, the *Angle* at A be 29 *deg.* 00′; I demand the *Bace* A C, and the *Perpendicular*, in the Triangle (I.)

I. *To*

1. *To find the* Bace A C.

As *Radius*, or *Sine* C 90 *deg.* 00′	
Is in proportion to A B the *Hypoth.* 242 paces;	2.38381
So is *Sine* B (the Complement of A to 29 *deg.*) S 61 *d.* 00′	9.94181
To the *Bace* A C, 212 paces neareſt.	2.32562

The *Bace* is not full 212 paces; which fraction being neglected may cauſe ſome inconſiderable difference in the Courſe, when things are given to find that. I note it here as a thing I do on purpoſe for the Learners ſake, that ſo he may not be at a ſtand when he meets with things not to hit exactly to a minute.

2. *To find the* Perpendicular.

As *Radius* or *Sine* C 90 *deg.* 00′	
Is to A B 242 paces;	2.38381
So is *Sine* A 29 *deg.* 00′	9.68557
To C B the *Perpendicular* 117 paces.	2.06938

The Uſe of the *Tables* of *Sines*, *Tangents*, and *Logarithms*, I have ſhewed towards the end of the Book, next before the Tables themſelves.

Now this may be applied to Sailing, or many other things of this nature. We will apply it to Sailing.

Queſt. 1. *Admit I ſet from the* Lizard (*lying in North Latitude* 50 deg. 00 min.) *and ſail South South Weſt* 6 deg. 30 min. *Weſterly* (*that is, South* 29 deg. *Weſterly*) 242 *leagues*; *I demand what* Latitude *I am in, and my departure, in the* Triangle *following*, A B C (2.)

LEt the ſide A B repreſent the diſtance run 242 leagues, and the Angle at A be 29 *deg.* 00′, (then is B, the Complement of A to 90 degrees, 61 *deg.* 00′): ſo that we have the Angles and one ſide given to find the ſide A C.

1. *For the difference of Latitude.*

As *s.* C. 90 *deg.* or *Radius*,	
To B A 242 leagues;	2.38381
So is *s.* B 61 *deg.* 00′	9.94181
To A C the difference of *Latitude* required 212 leagues or 10 *deg.* 36′.	2.32562

2. *For the Meridian-distance* B C.

As *Radius* or *s.* C 90 *deg.* 00′,	
Is to A B 242 leagues;	2.38381
So is *s.* A 29 *deg.* 00′,	9.68557
To B C the *Meridian-distance* 117	2.06938

Thus the *Meridian-distance* is 117, and ſomething more; the fraction I omit: and this ſhall ſerve for the reſolution of two Caſes in a Triangle; namely, when the *Angles* and *Hypothinuſe* is given to find the *Perpendicular*; and when the *Angles* and *Hypothinuſe* is given to find the *Base*: which things (required) are repreſented by the *difference of Latitude* and *Meridian-diſtance*.

Note, That *s.* ſtands for *Sine*, *t.* for *Tangent*, *s. co.* for *Sine Complement*, *t. co.* for *Tangent Complement*, *co. ar.* for *Complement Arithmetical*. ✠ ſtands for *more*, ---- ſtands for *leſs*, = ſtands for *equal*.

Note, That if you would find a *Side*, you muſt begin with an *Angle*; if you would find an *Angle*, you muſt begin with a *Side*.

To reſolve the foregoing Queſtion by Mr. Gunter's *Ruller.*

YOu ſee that the *Sine* of every *Angle* is proportional to its oppoſite ſide, or the Convers. It ſtands to reaſon then, that as a ſide is to another ſide, ſo is the *Sine* of an *Angle* oppoſite to that ſide, in proportion to the *Sine* of an *Angle* oppoſite to that other ſide. So that I'll ſay, to find the *Departure*,

As *Radius s.* C, 90 *deg.*
Is to *s.* A 29 *deg.* 00′;

So

So is A B the side opposite to *Radius* A B 242 leagues,
To B C the departure 117 leagues, the side opposite to A.

Fix one foot of your Compasses in 90 *deg.* 00′ on the Line of *Sines*, and extend the other to 29 *deg.* on the same.

With that distance, fix your Compasses at 242 on the Line of *Numbers*, and where the other foot falls under or less than this number, is the fourth number required; as B C 117 leagues, (and why less?) because from a greater Angle (namely *Radius*) you extend to a less. Therefore from the side that is opposite to the greatest Angle, you must have a less side; for the *greatest side* subtends the *greatest Angle*, &c.

2. *For the difference of Latitude* A C.

As *Radius* or *Sine* C 90 *deg.* 00′,
Is to *Sine* B 61 *deg.* 00′;
So is the distance run 242 A B,
To the difference of Latitude A C 212 leagues.

Fix one foot of your Compasses in *Radius* on the Line of *Sines*, and extend the other to 61 *deg.*

That distance set on the Line of Numbers at 242, and it reacheth to a number less; namely, 212, the difference of Latitude. And thus you may resolve any Questions of this nature, by *Gunter's Ruler.*

You may in these and all other Questions of this nature, frame your proportions, as when you work by the Tables (opposite sides and Angles one with another) and 'twill do the same thing; as suppose in this second proportion wrought by *Gunter*, I put opposite sides and Angles in proportion, thus:

As *Radius* or *s.* C 90 *deg.*
Is to A B the distance run 242 leagues;
So is *s.* B 61 *deg.* 00′,
To A C the difference of Latitude 212 leagues.

Fix one foot in *Radius* on the Line of *Sines*, and extend the other to the distance run on the Line of Numbers. That distance carry to 61 degrees on the Line of Sines, and see where the other foot falls on the Line of Numbers, which will be at 212.

Now this way, though as true as the other, will be troublesome in some Cases, because of the great distance that will be sometimes; but I leave every one to their own mind, for that both ways being very easie and alike true.

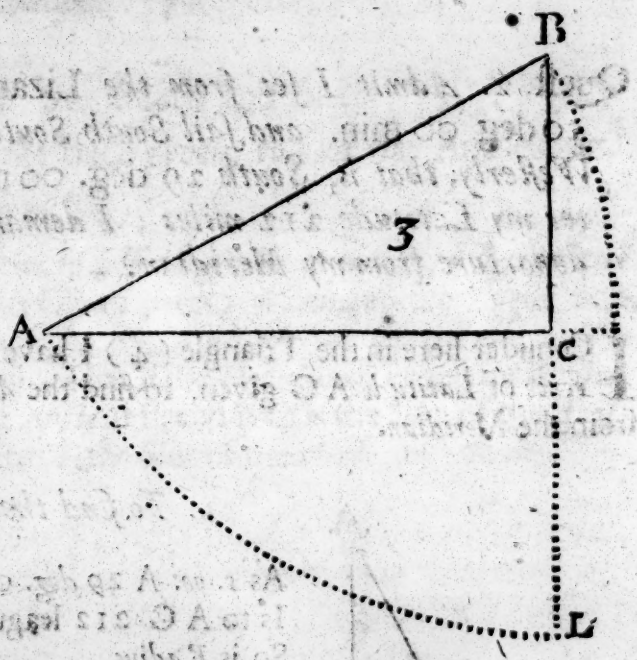
CASE

CASE the second and third.

The Bace *and the* Angles *given, to find the* Perpendicular *and the* Hypothinuſe.

In the *Triangle* A B C,

Let the *Bace* A C be 212 paces,
The Angle at A be 29 *deg.* 00′;
Then is the Angle at B 61 *deg.* 00′,
The Complement of A to 90 *deg.*
} I demand the Perpendicular or the ſide B C?



I conſider the Rule, that every Angle is proportional to his oppoſite ſide, or that every ſide is proportional to the Sine of his oppoſite Angle.

Therefore, putting A B for *Radius* (as before,) B C is the Sine of the Angle at A, and A C is the Sine of the Angle at B, or the Sine of the meaſure of the Arch L A.

I ſay then, to find the Perpendicular B C.

As *Sine* B 61 *deg.* 00′ *co. ar.*	0.05818
Is to A C 212 paces;	2.32633
So is *s.* A 29 *deg.* 00′,	9.68557
To the Perpendicular B C 117	2.07008

For the Hypothinuſe.

As *s. co.* A 29 *deg.* 00′ *co. ar.*	0.05818
Is to A C 212 paces;	2.32633
So is *s.* C. 90 *deg.*	
To A B the Hypothinuſe 240 paces	2.38451

So is A B the side opposite to *Radius* A B 242 leagues,
To B C the departure 117 leagues, the side opposite to A.

Fix one foot of your Compasses in 90 *deg.* 00′ on the Line of *Sines*, and extend the other to 29 *deg.* on the same.

With that distance, fix your Compasses at 242 on the Line of *Numbers*, and where the other foot falls under or less than that number, is the fourth number required; as B C 117 leagues, (and why less?) because from a greater Angle (namely *Radius*) you extend to a less. Therefore from the side that is opposite to the greatest Angle, you must have a less side; for the *greatest side* subtends the *greatest Angle*, &c.

2. *For the difference of Latitude* A C.

As *Radius* or *Sine* C 90 *deg.* 00′,
Is to *Sine* B 61 *deg.* 00′;
So is the distance run 242 A B,
To the difference of Latitude A C 212 leagues.

Fix one foot of your Compasses in *Radius* on the Line of *Sines*, and extend the other to 61 *deg.*

That distance set on the Line of Numbers at 242, and it reacheth to a number less; namely, 212, the difference of Latitude. And thus you may resolve any Questions of this nature, by *Gunter*'s *Ruler*.

You may in these and all other Questions of this nature, frame your proportions, as when you work by the Tables (opposite sides and Angles one with another) and 'twill do the same thing; as suppose in this second proportion wrought by *Gunter*, I put opposite sides and Angles in proportion, thus:

As *Radius* or *s.* C 90 *deg.*
Is to A B the distance run 242 leagues;
So is *s.* B 61 *deg.* 00′,
To A C the difference of Latitude 212 leagues.

Fix one foot in *Radius* on the Line of *Sines*, and extend the other to the distance run on the Line of Numbers. That distance carry to 61 degrees on the Line of Sines, and see where the other foot falls on the Line of Numbers, which will be at 212.

Now this way, though as true as the other, will be troublesome in some Cases, because of the great distance that will be sometimes; but I leave every one to their own mind, for that both ways being very easie and alike true.

CASE

CASE the second and third.

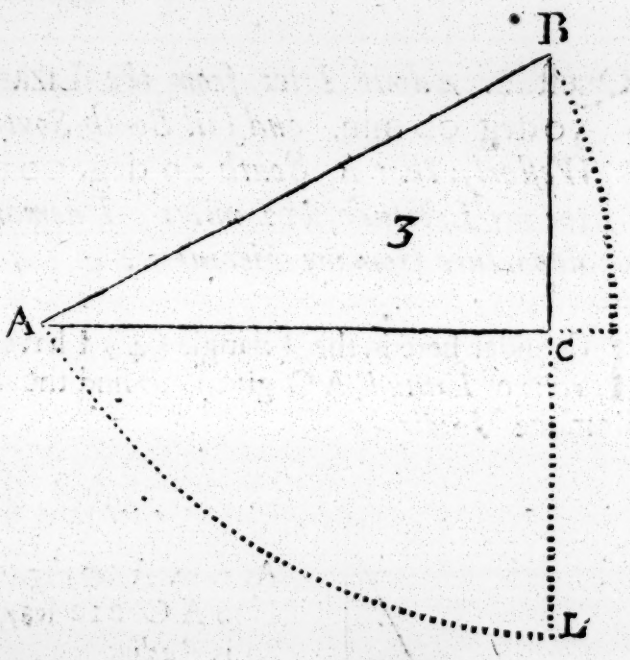
The Base *and the* Angles *given, to find the* Perpendicular *and the* Hypothinuse.

In the *Triangle* A B C,

Let the *Base* A C be 212 paces,
The Angle at A be 29 *deg.* 00′;
Then is the Angle at B 61 *deg.* 00′,
The Complement of A to 90 *deg.*
} I demand the Perpendicular or the side B C?

I consider the Rule, that every Angle is proportional to his opposite side, or that every side is proportional to the Sine of his opposite Angle.

Therefore, putting A B for *Radius* (as before) B C is the Sine of the Angle at A, and A C is the Sine of the Angle at B, or the Sine of the measure of the Arch L A.



I say then, to find the Perpendicular B C.

As *Sine* B 61 *deg.* 00′ *co. ar.*	0.05818
Is to A C 212 paces;	2.32633
So is *s.* A 29 *deg.* 00′,	9.68557
To the Perpendicular B C 117	2.07008

For the Hypothinuse.

As *s. co.* A 29 *deg.* 00′ *co. ar.*	0.05818
Is to A C 212 paces;	2.32633
So is *s.* C. 90 *deg.*	
To A B the Hypothinuse 240 paces	2.38451

The reaſon why I ſay *s. co.* A, is becauſe B is the Complement of A to 90 *deg.* ſo that in ſaying *s. co.* A, I take the *Sine* of B 61 *deg.* 00′.

Note, That when *Radius* is not in the firſt place, you muſt take the *Complement Arithmetical* of the firſt number or Angle.

Now the *Complement Arithmetical* of any *Sine*, is what the figures in the Tables anſwering to that number, wants of 9, as you may examine by the things preceding: the firſt of them, in each, is not the figures anſwering to them, but what them figures want of 9.

Queſt. 2. *Admit I ſet from the* Lizard, *Latitude Northerly* 50 deg. 00 min. *and ſail South South Weſt* 6 deg. 30 min. *Weſterly, that is, South* 29 deg. 00 min. *Weſterly, till I alter my Latitude* 212 *miles*; *I demand my diſtance run, and departure from my Meridian?*

I Conſider here in the Triangle (4) I have the *Angles* and the *difference* of *Latitude* A C given, to find the *diſtance run*, and *departure* from the *Meridian*.

1. *To find the* diſtance run A B.

As *s. co.* A 29 *deg.* 00′ *co. ar.*	0.05848
Is to A C 212 leagues;	2.32633
So is *Radius*	
To B A the diſtance run 242	2.38481

2. *For the departure from the Meridian* B C.

As *s. co.* A 29 *deg.* 00′ *co. ar.*	0.05818
Is to A C 212 leagues;	2.32633
So is *s.* A 29 *deg.* 00′	9.68557
To B C the departure 117	2.07008

By

By Mr. Gunter, *for the* distance run A B.

As *s. co.* A, which is *s.* B 61 *deg.* 00′,
Is to *Radius*;
So is A C 212
To A B 242 leagues.

2. *For the departure* B C.

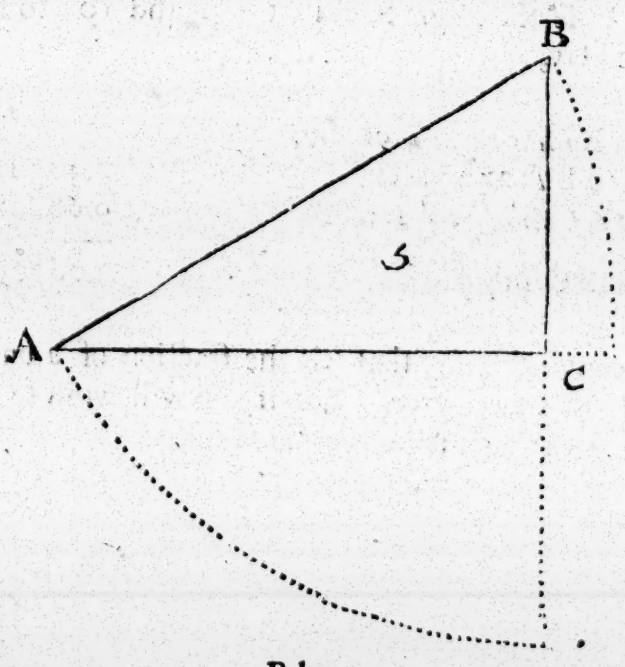
As *s.* B 61 *deg.* 00′,
Is to *s.* A 29 *deg.*
So is A C 212 leagues,
To B C the departure 117 leagues.

CASE the fourth and fifth.

The Hypothinuse *and the* Base *given, to find the* Angles, *and the* Perpendicular.

LEt the *Hypothinuse* in the fifth Triangle be as before, A B 242 paces, and the *Base* be A C 212 paces; I demand the *Angles* and the *Perpendicular*?

I consider still the old Rule, That if the *Hypothinuse* be put for *Radius*, then A C is the Sine of the *Angle* at B, and B C is the Sine of the *Angle* at A, and A B is the measure of the Sine of the *Angle* at C 90 *deg.*



Therefore for the Angles:

As B A 242 *co. ar.*	7.61618
Is to *Radius* or *s.* C 90 *deg.*	
So is A C 212 paces	2.32633
To *s.* B 61 *deg.* 10′	9.94251

And this 61 *deg.* 10′ is occasioned to be ten minutes too much, through the neglect of the fraction of the parts of a unite in working for the sides before in the three Cases already handled. I noted the reason why I did it so once before, that when a Learner comes to find such an errour in his work, he may know how it comes to pass. I hope no body will carp at me for this; for 'tis a mental Resolution: and I think the reason for it will stand good to any judicious person.

Next, for the Perpendicular B C.

I may say, As *Radius* C 90 *deg.*	
Is to B A 242;	2.38381
So is *s. co.* B 61 *deg.* 00′	9.68557
To B C 117 paces.	2.06938

But admit I use the *Angle* found 61 *deg.* and 10′, to find the Perpendicular, and say,

As *Radius* or *s.* C 90 *deg.*	
Is to B A 242 paces;	2.38381
So is 61 *deg.* 10′ *s. co.* B,	9.68328
To B C 117 paces.	2.06709

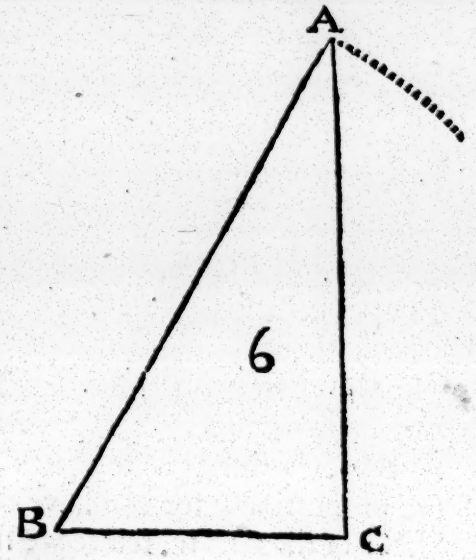
This may convince you, that 'tis the fraction of a unite that puts the Course out 10′ of a degree. But if you will work to the tenth or hundredth part of a unite, see before the Tables.

Quest.

Queſt. 3. *Admit I ſet from a certain Port, and ſail upon ſome point between the South and the Weſt* 242 *leagues, till I alter my Latitude* 212 *leagues or* 10 deg. 36 min. *I demand my Courſe and departure from the Meridian?*

THis Queſtion is as though the *Perpendicular* and the *Hypothenuſe* were given to find the *Angles* and *Base*; which differs not from the former Caſe in operation, but onely in the ſtanding of the *Angle:* and I ſet it thus, that you may ſee it's the ſame thing in effect: for,

I put B A for *Radius*, then is B A the Sine of the *Angle* at C, or *Radius*; and A C is the Sine of the *Angle* at B: ſo that,



For the Angles.

As A B 242 leagues *co. ar.*	7.61618
Is to *s.* C *Radius* 90 *deg.*	
So is A C 212 leagues, the difference of Latitude,	2.32633
To *s.* B 61 *deg.* 10′	9.94251

For the Departure B C.

As *Radius*	
Is to A B 242 leagues;	2.38381
So is *s.* A 28 *deg.* 50′	9.68328
To B C 117 leagues.	2.06709

By Mr. Gunter's *Ruler: Firſt, for the* Angles.

As A B 242 leagues,
Is to A C 212 leagues;
So is *s.* C 90 *deg.* 00′,
To *s.* B 61 *deg.* 10′.

Fix

Fix one foot of your Compaſſes in 242 on the Line of Numbers, and extend the other to the leſſer number 212: carry that diſtance to *Radius*, and the other foot will fall in 61 *deg.* 10′; which is---

Next for B C.

As *Radius*
Is to *s.* A 28 *deg.* 50′;
So is A B 242 leagues,
To B C 117 leagues.

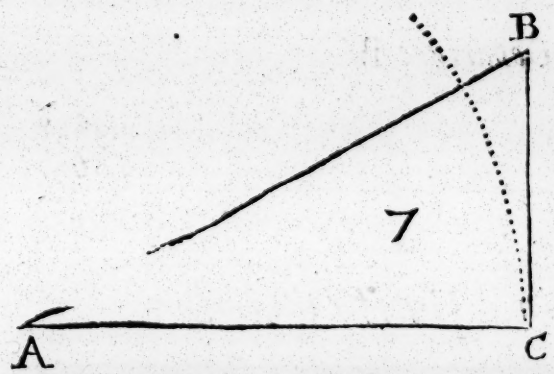
CASE the ſixth and ſeventh.

The Bace *and* Perpendicular *given, to find the* Angles *and the* Hypothinuſe.

LEt the *Bace* in the ſeventh Triangle be A C 212 paces, and the *Perpendicular* C B; I demand the *Angles* and the *Hypothinuſe*?

In this caſe things be ſo given, that you cannot put them in an oppoſite proportion; for you have two ſides given, but nothing oppoſite to either of them: therefore we muſt find another Rule to work them by.

I have ſaid before, that any of the three ſides may be put for *Radius*, and the other ſides ſhall be as *Sines*, *Tangents*, or *Secants*, by them repreſented. Now the ſame proportion the ſide put, as *Radius* hath to *Radius*, the ſame proportion ſhall the other ſides have to the *Sine*, *Tangents*, or *Secants* by them meaſured.



In this caſe put A C for *Radius*, or the Semi-diameter of the Circle the Scale was made by, or the *whole Sine*; and then B C is the *Tangent* of the *Angle* at A, and the Proportion will ſtand thus:

As the ſide put for *Rad.* A C,
Is in proportion to *Radius* or *Sine* C 90 *deg.* 00′;
So is B C the meaſure of the *Tangent* of the *Angle* at A,
To the *Tangent* of the *Angle* at A.

And

And this is evident, if you look upon the projection of the *Tangent* Line, where O B is the *Radius* the Scale was made by, and B S the measure of the *Angle* B O S, or the *Tangent* of the Arch R B.

Therefore for the Angles A *and* B.

As A C the *Base* 212 paces *co. ar.*	7.67366
Is to *Radius* or *Sine* C 90 *deg.* 00′ ;	
So is B C 117 paces,	2.06818
To the *Tangent* of the *Angle* at A 28 *deg.* 54′	9.74184
Whose Complement to 90 *deg.* is B 61 *deg.* 6′.	

Next, for the Hypothinuse.

I consider with my self, that I have given all the *Angles* of the Triangle A C B, and two sides: I say then,

As *Sine* B 61 *deg.* 00′ *co. ar.*	0.05776
Is to A C 212 paces ;	2.32633
So is *Radius* or *s.* C 90 *deg.* 00′	
To the *Hypothinuse* A B 242 paces.	2.38409

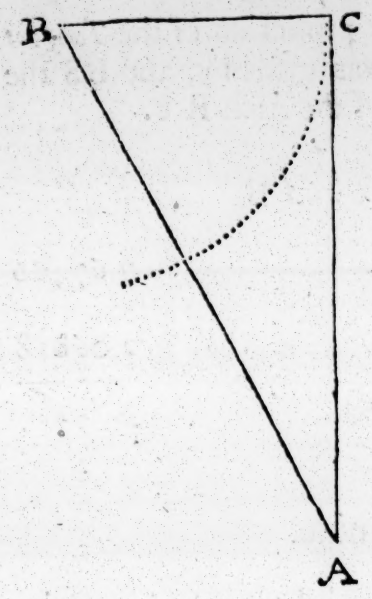
Quest. 4. *Admit I set from a certain Port, and sail upon some point between the South and the East, till I alter my Latitude* 212 *miles, or* 3 deg. 32 min. *and depart from my Meridian* 117 *miles; I demand my Course and distance ran.*

This is but as it were the Case before applied to plain Sailing: for in the Triangle A B C is given the side A C 212 leagues, and then,

First, for the Angle: I put B C *as* Radius, *and say,*

As the side put for *Radius* B C 117 leagues *co. ar.*	7.93181
Is to *Radius* or *Sine* C 90 *deg.*	
So is C A 212 leagues ;	2.32633
To t. B 61 *deg.* 00′	10.25814

The



The bearing of the other place from the Northermoſt Ship, which is East 61 deg. Southerly. And thus you have ſeen that any of the three ſides may be put for Radius, and the other ſides ſhall be as *Sines* or *Tangents* by them repreſented. I will not meddle with a *Secant*, it being needleſs; all things being better done, and with more eaſe, without it.

Theſe *Angles* being found, we'll next find the diſtance run A B.

As *Sine* A 29 *deg.*	0.3144
Is to B C 117 leagues;	2.0681
So is *Radius* or *s.* C 90 *deg.*	
To B A 242 leagues.	2.3826

The ſame by Gunter's *Ruler.*

Firſt, for the Angles, *I put* B C *as* Radius, *and ſay,*

As B C 117 leagues,
Is to C A 212 leagues;
So is *Radius t.* 45 *deg.*
To *t.* B 61 *deg.* 00′.

Fix one foot of your Compaſſes in 117 leagues on the Line of Numbers, and extend the other foot to 212; with that diſtance fix one foot of your Compaſſes in 45 *deg.* (which is the *Radius* of a *Tangent*) and where the other foot falls, is the *Tangent* of the *Angle* at B above 45 *deg.* namely 61 *deg.* 00′: for if your firſt extent was from a leſſer number to a greater, as from 117 leagues to 212 leagues, the third muſt give for the fourth a greater than it ſelf; as here *Radius* or *t.* 45 *deg.* gives the *Tangent* downwards increaſing. In working by a *Tangent* Line, be very careful to conſider of theſe things.

Next, for the diſtance run A B.

As *s.* B 61 *deg.*
Is to *Radius* or *Sine* C 90 *deg.*
So is C A the difference of Latitude 212,
To B A the diſtance run 242 leagues,

Fix

Fix one foot of your Compasses in 61 *deg.* on the Line of Sines, and extend the other to *Radius*; that distance carry to 212 on the Line of Numbers, and see how much it will increase it: it falls at 242 leagues.

Here I might in the next place shew the working of a Travers by the Tables and *Gunter*'s Rule, but let this suffice: for the working a Travers, is but doing the same Cases divers times, and is very tedious; your own reason will give you the doing of it; the Tables of Longitude and Latitude be far better.

CASE the Eighth.

The Base *of a Triangle given alone, the* Perpendicular *and the* Hypothinuse *given together, to find them several.*

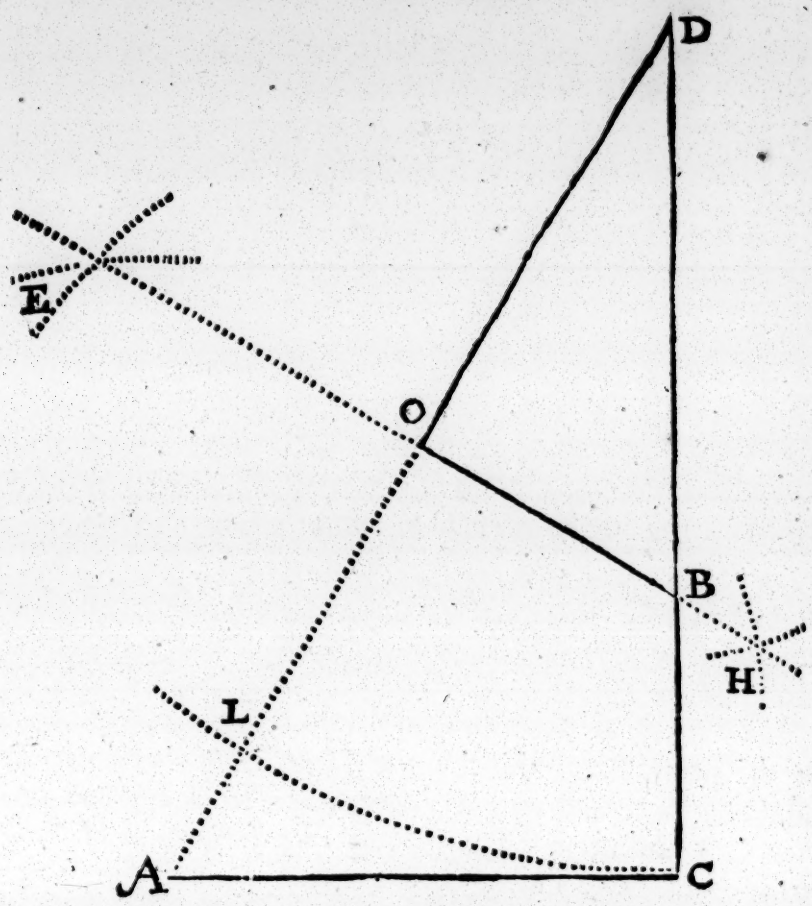
Admit the Base *of a Triangle be* A C 212 *foot, the* Perpendicular *and* Hypothinuse *of the same Triangle be together* 359 *foot; I demand them several, and the Angles.*

FOr the protracting this by the *Plain Scale*, lay down C A the *Base* 212 foot, and raise a *Perpendicular* from any end of it (as here from C) and upon it set off the *Perpendicular* and *Hypothinuse*, as they are given, in one sum 359 foot from C upon it, and it reacheth to D; draw the side D A, and it makes the Triangle C D A; divide the *Hypothinuse* A D into two equal parts by the Perpendicular E H, and it cuts the first Perpendicular in B.

Now forasmuch as B D and B A are equal, (for A O and O D are equal, and O B is a Perpendicular to both the Triangles D O B, and B O A) therefore their *Hypothinuse* B A and B D must be equal. I say then, they being equal, B A + B C is = to D B + B C or C D the two sides given together: so that now if you measure the side A B, it's the *Hypothinuse* alone, and C B the *Perpendicular*; and for the *Angle* C A B, measure it as you do another *Angle* from an Arch of 60 degrees.

By the Tables.

I consider that I have given me in the Triangle D C A the Perpendicular D C 359 foot, and the *Base* C A 212 foot, whereby I find the *Angle* at D (as by the fourth Case.)



Thus putting D C *for* Radius,

As D C 359 foot *co. ar.*	7.4449
Is to *Radius*;	
So is A C 212 foot	2.3263
To *t.* D 30 *deg.* 34′	9.7712

Now this *Angle* at D ſubſtracted from 90 degrees, leaves the *Angle* D A C; from which, if you ſubſtract the *Angle* B A O, (which is equal to the *Angle* found at D) it leaves the *Angle* C A B 28 *deg.* 52′. So that now we have the *Angles* of the Triangle A C B, and the Baſe C A, to find the Perpendicular C B, and the *Hypothinuſe* B A, as is ſhewed in the ſecond and third Caſe of *Right angled Triangles.*

Therefore

Therefore for the Hypothinuſe A B,

As *s.* B 61 *deg.* 8′ the Compl. of O A B to 90 *deg. co. ar.*	0.057622
Is to C A 212 foot;	2.326335
So is *Radius* or *s.* C 90 *deg.*	
To A B the *Hypothinuſe* required 242 feet.	2.383957

Secondly, for C B *the* Perpendicular.

As *s.* B 61 *deg.* 08′ *co. ar.*	0.057622
Is to C A 212 foot;	2.326335
So is *s.* A 28 *deg.* 52′,	9.683743
To B C the Perpendicular 117 miles.	2.067700

The ſame by Gunter's *Ruler.*

Firſt, for the Angle D.

As D C 359 foot,
Is to A C 212 foot;
So is *Radius* or C *t.* 45 *deg.*
To *t.* 30 *deg.* 34′.

Set one foot of your Compaſſes in 359 on the Line of Numbers, and extend the other foot to 212 on the ſame: carry that diſtance to the *Radius* of your *Tangent*-line 45 *deg.* and where the other falls on that Line, is your deſire, A.

Next, for the Hypothinuſe.

As *s.* B 61 *deg.* 08′,
Is to *Radius s.* D 90 *deg.*
So is C A 212 foot,
To B A 242 foot.

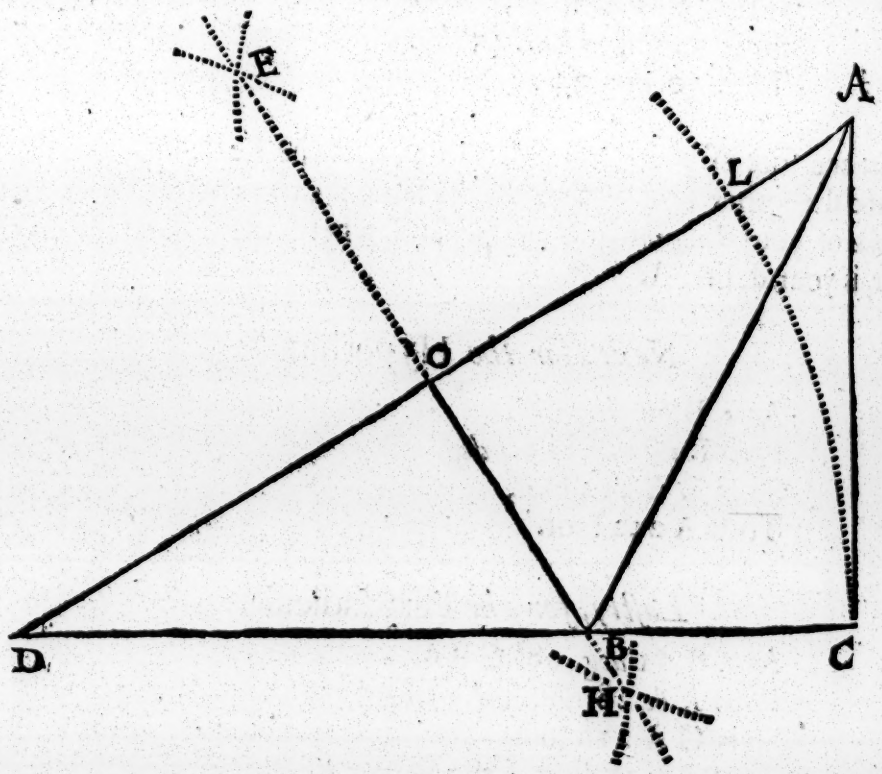
Laſtly, for the Perpendicular.

As *s.* B 61 *deg.* 08′ C B A,
Is to *s.* A 28 *deg.* 52′ C A B;
So is C A 212 foot,
To B C 117 foot (the Perpendicular.)

Examples of this nature I have ſhewed in the Caſes before handled, to which I refer you.

Queſt. 5. *Admit I ſet from a certain Port, and ſail upon ſome point between the South and the Weſt, till I alter my Latitude* 3 deg. 32 min. *or* 212 *miles, and my diſtance that I have run, and departure from the Meridian, together be* 359 *miles; I demand them ſeveral, and the Courſe made good?*

THis Queſtion is laid down by the Plain Scale, as the preceding Caſe is; A C being the *difference of Latitude*, C D the *diſtance run*, and Meridian-diſtance, D A the *Hypothinuſe* of the great Triangle divided into two parts in the point O, by the Perpendicular-line E H, and ſo cutting the diſtance run and Meridian-diſtance together in the point B; ſo that B A being drawn, it is equal to B D, (and makes the Ships diſtance run) and B C her departure: for A B being equal to B D, it muſt with B C be equal to B D (the diſtance run and departure:) meaſure them and the *Angle* B A C for to know the Courſe, as a common Triangle.



To reſolve this by the *Tables*, or *Gunter*, 'tis the ſame as the other was. You

You have given A C the difference of Latitude 212 miles, and C D the distance run, and departure together, 559 miles, to find the *Angle* at D.

Putting D C *for* Radius, *I say then,*

As D C 359 miles *co. ar.*	7.4449
Is to *Radius* 90 G	
So is A C 212 miles,	2.3263
To *t.* D 30 *deg.* 34′	9.7712

Now this substracted from 90 *deg.* leaves the *Angle* D A C; from which, if you substract the *Angle* O A B, which is equal to the *Angle* D found, the remainder is B A C the Ships Course, which is South 28 *deg.* 52′ Westerly.

So that now we have A C given, and C B A (the *Complement* of A to 90 *deg.*) 61 *deg.* 08′ to find B C and B A.

First, for the Departure B A.

As *s.* C B A 61 *deg.* 08′ *co. ar.*	0.057622
Is to A C 212 miles;	2.326335
So is *s.* B A C 28 *deg.* 52′	9.683743
To B C the departure 117 leagues.	2.067700

Secondly, for the Distance A B.

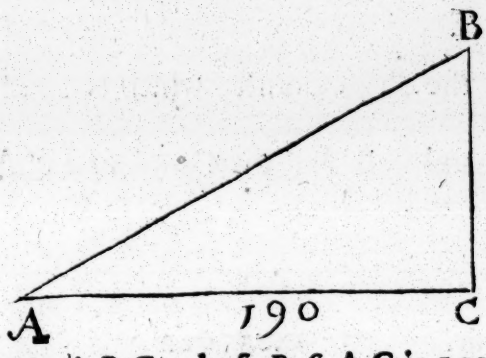
As *s.* C B A 61 *deg.* 08′ *co. ar.*	0.057622
Is to C A 212 leagues;	2.326335
So is *Radius*	
To B A 242 leagues.	2.383957

CASE

CASE the Ninth.

The Angles of a Triangle being given, distinguisht, and the Sides given in one sum, to find the Sides severally.

In the Triangle following ABC, *let the Angle at* C *be a Right Angle, the Angle at* A *be* 28 deg. 52′, *then is the Angle at* B 61 deg. 08′, *and let the three sides of this Triangle be* 571 *foot, or paces, leagues, or miles (which you will) I demand them several?*



TO resolve this Question, I gueſs at ſome one ſide of the Triangle that I would find the ſides of; and here I gueſs that the *Baſe* of this Triangle may be 190; and with this gueſs, and the Angles diſtinctly given (in the Queſtion or Caſe) I lay down the Triangle A B C whoſe *Baſe* A C is 190, the *Angle* at A, 28 *deg.* 52′, the *Angle* at B 61 *deg.* 08′.

Firſt then, for A B.

As *s.* B 61 *deg.* 08′ *co. ar.*	0.057622
Is to A C 190;	2.278753
So is *Radius* C 90 *deg.*	
To A B 217	2.336375

Secondly, for B C.

As *s.* B 61 *deg.* 08′ *co. ar.*	0.057622
Is to A C 190;	2.278753
So is *s.* A 28 52	9.683743
To C B 105	2.020118

I now adde theſe ſides found to the gueſſed ſide, and ſee if my Work be right or no.

Here I find that the ſides of this Triangle are but 512, and they ſhould be 571. I'll ſay then,

The *Baſe* A C	190
The ſide A B	217
The ſide C B	105
Their ſum	512

If

If 512 the sum of the sides of the Triangle guessed, *co. ar.*	7.29072
Gives for his *Base* A C 190,	2.27875
What shall the sum of the given sides 571 give for the *Base?*	2.75663
Facit 212	2.32610

So that now we have the *Base* of the Triangle required, and the Angles distinctly, to find the other sides, or to lay the Triangle truly down by the Scale. I'll leave the practice of it to your self. And to resolve it by Mr. *Gunter*'s Rule, it's what I have shewed before, except the last Proportion; and for that,

Fix one foot of your Compasses in 512 on the Line of Numbers, and extend the other foot to 190: that distance carry to 571, and see what the other foot gives less--*Facit* 212. I write *Facit*, for that indeed 'tis the Rule of Three, and might have been resolved that way sooner; but we are treating of the Use of the Tables of *Sines*, *Tangents*, and *Logarithms*.

CHAP. XXVII.

Of Oblique Triangles.

CASE 1.

The Angles *of an Oblique Triangle, with one of the* Sides *given, to find the other two* Sides.

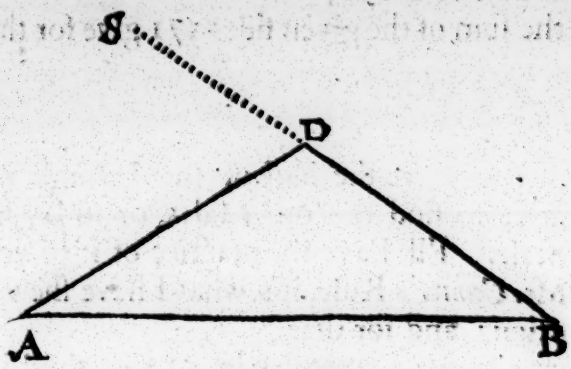
In the Triangle A D B, *let the Angle at* A *be* 29 deg. 30', *the Angle at* B 36 deg. 56', *the Side* B D *be* 200 *paces*; *and let it be required to find the Sides* D A *and* A B.

FOr the resolving any Question of this kind, the first General Rule is to be observed; and that was, That in all right lined Triangles, whether right angled or not,

A General Rule.

The Sine of every Angle is really proportional to his opposite Side, or every Side

Side is proportional to the Sine of his oppoſite Angle. And therefore,



For A D.

As *s.* A 29 *deg.* 30′ *co. ar.*	0.30766
Is to D B 200 paces;	2.30103
So is *s.* B 36 *deg.* 56′	9.77879
To D A 244 paces.	2.38746

Next, for the Side A B.

As *s.* A 29 *deg.* 30′ *co. ar.*	0.30766
Is to D B 200 paces;	2.30103
So is *s.* D its *Compl.* to 180 *deg.* 66 *deg.* 26′ A D S,	9.96217
To A B 372 paces.	2.57086

The reaſon I take the *Complement* off the *Angle* at D to 180 degrees is, becauſe the *Sine* of an *Angle* greater than 90 *deg.* is alſo the *Sine* of an *Angle* as much leſs. The Tables go to 90 *deg.* and in this ſence to 180 *deg.*

Queſt.

Queſt. 6. *Admit there be two places in one Latitude or Parallel, diſtant 72 leagues; a Ship ſets from the Eaſtermoſt of theſe places, and ſails Weſt* 36 deg. 56 min. *Northerly, that is, North Weſt by Weſt* 3 deg 11 min. *Northerly, and meets with a Ship that came from the Weſtermoſt place, and had ſailed Eaſt North Eaſt* 7 deg. *Northerly, that is, Eaſt* 29 deg. 30 min. *Northerly; I demand each Ships diſtance run?*

IN the preceding Triangle I have the ſide B A given 372 miles, the *Angle* at A 29 *deg.* 30′, the *Angle* at D 113 *deg.* 34′, the *Angle* at B 36 *deg.* 56′.

For the Side D B, *the Eaſtermoſt Ships diſtance run.*

As *s.* D 113 *deg.* 34′, its *co.* to 180 *deg.* A D S 66 *deg.* 26′ *co, ar.*	0.03782
Is to A B 372 leagues;	2.57054
So is *s.* A 29 *deg.* 30′	9.69233
To D B 200 leagues.	2.30069

Secondly, for D A.

As *s.* A D S 66 *deg.* 26′ *co. ar.*	0.03782
Is to A B 372 leagues;	2.57054
So is *s.* B 36 *deg.* 56′	9.77879
To A D 244 leagues.	2.38715

To perform the ſame by Mr. Gunter's *Ruler.*

And firſt, for D B.

As *s.* D 113 *deg.* 34′, its *Compl.* to 180 *deg.* A D S 66 *deg.* 26′,
Is to *s.* A 29 *deg.* 30′;
So is A B 372 leagues,
To D B 200 leagues.

Set one foot of your Compaſſes in 66 *deg.* 26′ on the Line of *Sines*,

and extend the other to 29 *deg.* 30′ on the ſame Line with that diſtance: ſet one foot of your Compaſſes in 372 on the Line of Numbers, and the other will give the leſſer number 200.

Secondly, for A D.

As *s.* A D S 66 *deg.* 26′,
Is to *s.* B 36 *deg.* 56′;
So is A B 372 leagues,
To D A 244 leagues.

Set one foot on 66 26 in the Line of *Sines*, and extend the other to 36 *deg.* 26′ on the ſame Line that diſtance: ſet in 372 on the Line of Numbers, and you have the leſſer number 244 miles.

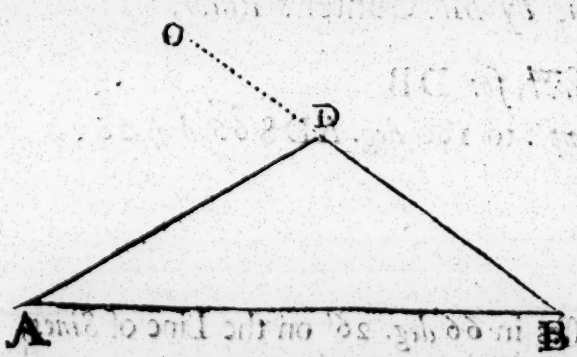
CASE 2.

Two Sides of a Triangle, with an Angle oppoſite to one of them, given, to find the other Angles, and the third Side.

In the Triangle A D B, *let* A B *be given* 372 *paces, the Side* D B *be* 200 *paces, and the Angle at* A *be* 29 deg. 30′; *I demand the other Angles, and the Side* D A.

To find the Angles.

As B D 200 paces *co. ar.*	7.69896
Is to *s.* A 29 *deg.* 30′;	9.69233
So is A B 372	2.57054
To *s.* D, its *co.* to 180 *deg.* 66 *deg.* 26′.	9.96183



Next, for the Side B A.

As *s.* A 29 *d.* 30′ *co. ar.*	0.30076
Is to B D 200 pac.	2.3010
So is *s.* D 66 *d.* 26′	9.9621
To A B 372 paces.	2.5707

The

The *Angle* at D being thus found (as you see above) you are to note, that 'twas the outward *Angle* A D O that was 66 *deg.* 26′, and must be substracted from 180 degrees, and then you have the *Angle* A D B 113 *deg.* 34′. Now to this you adde the *Angle* at A 29 *deg.* 30′, and substract that sum from 180 degrees, and it leaves the *Angle* at B, (if you have occasion for it); but here is none, unless it be to prove by it, that the outward *Angle* A D O was found right.

Admit you question it then: You'll say, the *Sine* of an *Angle* greater than 90 degrees, is also the *Sine* of an *Angle* as much lesser; and therefore I know not but it may be the inward *Angle* A D B that is found: for that is just as much greater than 90 degrees, as A D O is less than 90 degrees.

To answer this doubt, you know that the three *Angles* of any right lined Triangle, is but 180 degrees. I'll therefore

	deg.	*min.*
Adde the *Angle* found, which is in dispute here,	66	26
To the *Angle* given in the Question, A	29	30
And it makes the two *Angles* to be	95	56
Now them substracted from	180	00
Leaves for the *Angle* at B	84	04

Which is more than either of the two lesser *Angles* are.

Now this cannot be, because the greatest side subtends the greatest *Angle*: A B then is the greatest side, and therefore the *Angle* found is the outward *Angle* A D O, and must be substracted from 180 degrees, and then you have the inward *Angle* A D B 113 *deg.* 34′, which is the greatest *Angle*.

Quest. 7. *Admit I set from a certain Port, and sail West* 36 deg. 26 min. *Northerly; now there is another Ship in the same Latitude, and distant* 372 *leagues, that sails* 244 *leagues and meets me: I demand my own distance run, and his Course?*

IN the preceding Triangle, we have given the *Angle* at B 36 *deg.* 56′, the side B A 372 leagues, and the side A D to find the *Angles*, and the side B D.

First, for the Angles.

As A D 244 leagues *co. ar.*	7.61261
Is to *s.* B 36 *deg.* 56′ ;	9.77879
So is A B 372 leagues,	2.57054
To *s.* D 66 *deg.* 26′.	9.96195

If you ſubſtract the *Angle* at B from 66 *deg.* 26′, you have the *Angle* at A 29 *deg.* 30′. The Complement of this to 180 degrees, is the *Angle* of the Ships meeting, 113 *deg.* 34′ A D B.

Next, for the Side D B.

As *s.* D 66 *deg.* 26′ *co. ar.*	0.03782
Is to A B 372 leagues ;	2.57054
So is *s.* A 29 *deg.* 30′	9.69233
To D B 200 leagues.	2.30069

The ſame by Gunter's *Ruler.*

Firſt, for the Angles.

As A D 244 leagues,
Is to A B 372 leagues ;
So is *s.* B 36 56
To *s.* D 66 26.

Set one foot in 244 on the Line of Numbers, and extend the other to 372 on the ſame: that diſtance carry to 36 26 on the Line of *Sines*, and the other foot will fall at 66 *deg.* 26′.

Secondly, for the Sides.

As *s.* D 66 26,
Is to *s.* A 29 *deg.* 30′ ;
So is A B 372 leagues,
To D B 200 leagues.

Set one foot in 66 26 on the Line of *Sines*, and extend the other to 29 *deg.* 30′ on the ſame: carry that diſtance to 372 on the Line of Numbers, and the other gives 200 leagues, which is a leſs number.

CASE

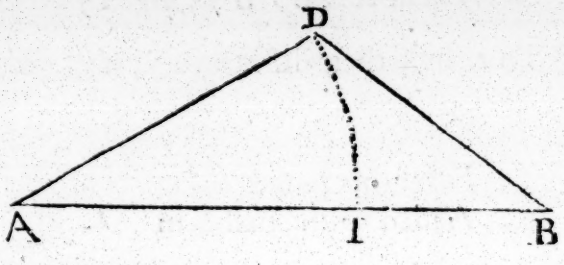
CASE 3.

Two Sides and the contained Angle given, to find the third Side and the other Angles.

Let there be given in the Triangle A D B *the Side* A B 372 *paces, the Side* A D 244 *paces, the Angle at* A 29 deg. 30′, *and let the Angles* B and D *be required, or the Side* D B.

IN this Caſe you have things ſo given, that you cannot put them in oppoſite proportion, but muſt find ſome other Rule to work by.

Therefore take the length of the ſhorteſt of the given ſides D A, and ſet it off upon the longeſt of the given ſides A B, and it cuts off the difference of the two ſides B I. Now,



General Rule.

As the ſum of the two ſides containing an Angle, is to the difference of thoſe ſides;
So is the Tangent of the half ſum of their oppoſite Angles, to the Tangent of half their difference.

So then, as the ſum of A B + A D, the given ſides 616 paces,
Is to their difference 126 paces B I;
So is the *Tangent* of the half ſum of B + D 75 *deg.* 15′,
To *t.* half their difference.

Now when this half difference is found, if you adde it to the half ſum, it will make the greateſt of the *Angles* required, namely D; if you ſubſtract it from the half ſum, it makes the leſſer *Angle* at B.

But you may ask how the half ſum of the unknown *Angles* is found to be 75 *deg.* 15′?

You know the three *Angles* of a Triangle is 180 *deg.* 00′; then if I have one of the *Angles* known, and ſubſtract that from the ſum of the three *Angles* (which is 180 *deg.* 00′) the remainder muſt be the other two; the half of which, is the ſum required.

Example.

Example.

	deg.	min.
The three *Angles* is	180	00
The *Angle* given is A, ſubſtract it	029	30
The ſum of B and D is	150	30
The half of which is	75	15

Theſe things premiſed, we proceed to the operation it ſelf.

For the Angles D *and* B.

As the ſum of A D + A B 616 *co. ar.*	7.21041
Is to their difference I B 126 ;	2.10037
So is *t.* half A D B + B 75 *deg.* 15′	10.57958
To *t.* half their difference 37 *deg.* 50′	9.89036

	deg.	min.
Now this found	37	50
Added to the half ſum	75	15
Gives the *Angle* D	113	05
Or ſubſtracted from the half ſum, leaves the *Angle* at B	37	25

The odde minutes of a degree that it differs from the Queſtion before, is occaſioned through the neglect of the fraction of a unite in finding the ſides ; which I omit for the Learners ſake, that he may not be puzled when he finds it ſo.

Next, for the Side B D.

As *Sine* B 37 25 *co. ar.*	0.21637
Is to D A 244 paces ;	2.38738
So is *Sine* A 29 *deg.* 30′	9.69233
To D B 199 paces.	2.29608

And thus you have the firſt Rule to help out where it doth not wholly do the Caſe ; and you ſee the errour of the neglect of the fractional parts of a unite, which in ſhort diſtances would not be ſo great in the ſides.

Queſt.

Queſt. 8. *Admit there be two places that bear Eaſt North Eaſt, and Weſt South Weſt one from the other, and are diſtant* 372 *leagues; a Ship ſets from the Eaſtermoſt of theſe places, and ſails Weſt* 14 deg. 26 min. *Northerly,* 200 *leagues: I demand the Ships diſtance from the Weſtermoſt Port, and how far he is from it?*

IN this Queſtion we have given in the following Triangle A D B, the ſide B A 372 leagues, the ſide B D 200 leagues, and the *Angle* at B 36 *deg.* 56′: for if B A be Weſt South Weſt, and B D be 14 *deg.* 26′ to the Northwards of the Weſt, then the *Angle* at B muſt be two points and 14 *deg.* 26′ more, which is 36 *deg.* 56′, or three points, and 3 *deg.* 11′, or Weſt by North 3 *deg.* 11′ Northerly.

To find the Angles D *and* A *then.*

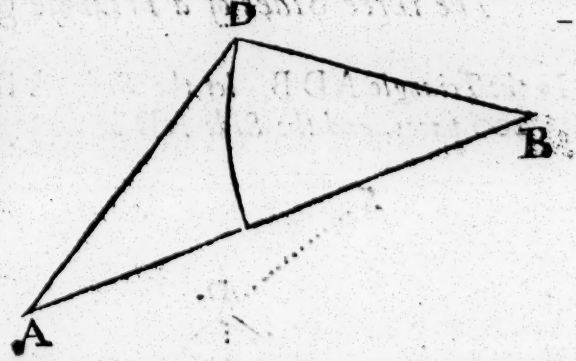
As the ſum of D B + B A 572 *co. ar.*	7.24260
Is to their difference 172 leagues;	2.23552
So is the *t.* of half D + A 71 *deg.* 32	10.47632
To the *t.* of half their difference 42 *deg.* 00′	9.95444

Which added to the half ſum, is 113 *deg.* 32′ A D B.
Or ſubſtracted from it, is 29 *deg.* 30′ the *Angle* at A.

Next, for the Side B A.

As *s.* D its *co.* to 180 *deg.* 66 *d.* 28′ *co. ar.*	0.0377
Is to A B 372 miles;	2.5705
So is *s.* B 36 *deg.* 56′	9.7787
To D A 244 leagues.	2.3869

The like for any other of this kind.



The ſame by Mr. Gunter's *Ruler.*

As the ſum of D B + B A 572 miles or paces, or what you do it by,
Is to their difference 172;

So

So is the *t.* of half D + A 71 *deg.* 32′
To the *t.* of half their difference 42 *deg.* 00′.
Which added to the half sum, makes the *Angle* at D 113 *deg.* 32′.
Or substracted from the half sum, makes the *Angle* A 29 *deg.* 30′.

Next, for B A.

As *s.* D its *Compl.* to 180 *deg.* 66 *deg.* 28′,
Is to *s.* B 36 *deg.* 56′;
So is A B 372 miles,
To D A 244 leagues.

For the doing the first of these, I set one foot of my Compasses in 572 on the Line of Numbers, and extend the other foot to 172: that distance I set upon the *Tangent*-line at 71 *deg.* 32′, and set my Compasses upwards towards the *Radius* of the Scale and count how much it is lesser, and it falls at 42 degrees.

Note, That a *Tangent*-line goeth from 1 upwards to 45 (its *Radius*) and so downwards increasing to 99, which made me decrease in my distance set upwards.

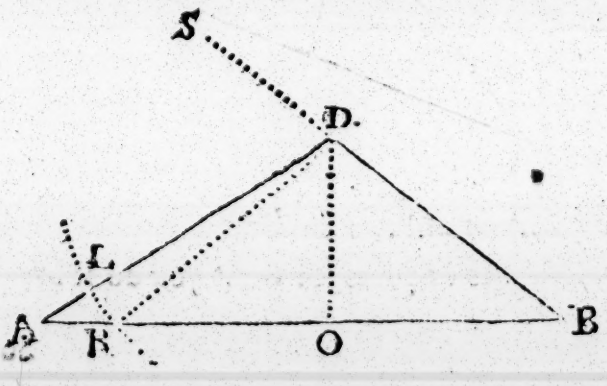
Next, for the side B A.

I set my Compasses on the Line of *Sines* at 66 *deg.* 28′, and extend them to 36 *deg.* 56′: that distance I set on the Line of Numbers at 372, and the other foot falls at 244; a less number, because the second *Angle* was a less *Angle*.

CASE 4.

The three Sides of a Triangle given, to find the Angle.

In the Triangle A D B, *let the Side* A B *be* 372 *paces, the Side* B D *be* 200 *paces, and the Side* A D *be* 244 *paces; I demand the Angles?*



WHen I have laid the Triangle down, I take the length of B D, and cut the Base B A in the point R, and A D in L, as is done by the Arch L R; also I let fall the Perpendicular

lar D O, which falls in the middle between B and R, becauſe B D and D R are equal, and O D the Perpendicular common to them both. This done, I frame this *General Rule.*

General Rule, *making* A B *the true* Baſe.

As the ſum of the true *Baſe* A B,
Is to the ſum of the other two ſides (added together);
So is the difference of the two ſides L A,
To the *alternate Baſe* R A.

Now this *alternate Baſe* being found, I ſubſtract it from the true *Baſe* A B, and the remainder is R B, the half of which is O B: ſo that now in the right angled Triangle D O B, right angled at O, you have O B given, and B D to find the *Angle* at B.

I ſay then, As D B is in proportion to *Radius*, ſo is B O in proportion to *ſ.* O D B, the Complement of which is A B D. Then for the other Angles; As A D (given in the Queſtion) is to *ſ.* B (the *Angle* found); ſo is B D (another ſide given in the Queſtion) to *ſ.* A; or ſo is A B to *ſ.* A D B (its Complement to 180 degrees.)

Example.

As the ſum of A B 372 paces, *co. ar.*	7.42945
Is to the ſum of B D + D A 444 paces;	2.64738
So is L A their difference 44,	1.64345
To R A the *alternate Baſe* 52 paces.	1.72028
Which ſubſtracted from A B 372 paces,	
Leaves R B 320 paces;	
The half of which is O B 160 paces.	

And now I have O B and B D in the right angled Triangle B O D, to find B.

As B D 200 paces *co. ar.*	7.69896
Is to *Radius* or *ſ.* D O B;	
So is O B 160,	2.20412
To *ſ. co.* O D B, which is the *ſ.* of B 36 53.	9.90308

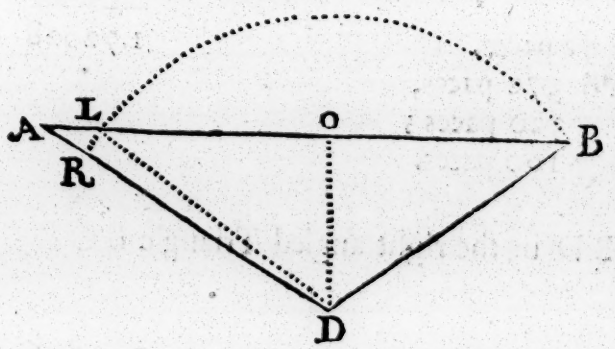
Laſtly, for the other Angles.

As D A 244 paces, *co. ar.*	7.61261
Is to *s.* B 36 *deg.* 53′;	9.77827
So is B D 200	2.30103
To *s.* A 29 *deg.* 29′.	9.69191

	deg.	*min.*
This *Angle* at A here found	29	29
Added to the *Angle* at B,	36	53
Makes A D S;	66	22
Which is the Complement of A D B to 180 *deg.*	113	38

And thus we have reſolved all the demands propounded in the Queſtion. The like is to be underſtood of any other of this nature.

Queſt. 9. *There be two places in one Parallel or Latitude diſtant* 372 *miles; a Ship ſets from the Eaſtermoſt of theſe places, and ſails upon ſome point between the South and the Weſt* 200 *leagues, and meets with a Ship that came from the Weſtermoſt of theſe places, and had ſailed* 63 *leagues: I demand each Ships Courſe?*



IN this Queſtion I have given A B 372 leagues, the Side B D 200 leagues, and the Side A D 244 leagues, to find the *Angles*. So that it is the very ſame as the preceding Caſe was, and wrought the ſame way.

I ſay then, to find the alternate Baſe L A.

As A B 372 leagues,	7.4294
Is to B D + D A 444;	2.6473
So is R A difference 44,	1.6434
To L A the *alternate* 52.	1.7202

This

This 52 here found, ſubſtracted from AB	372
And it leaves LB	320
The half of which is OB	160

So I have OB *and* BD *to find the Angle at* B.

As BD 200 *co. ar.*	7.69896	The Eaſtermoſt Ship ſailed S W by W 3 *deg.* 08′ Southerly.
Is to *Radius*;		
So is OB 160	2.20412	
To *ſ. co.* ODB or *ſ.* B 36 53	9.90308	

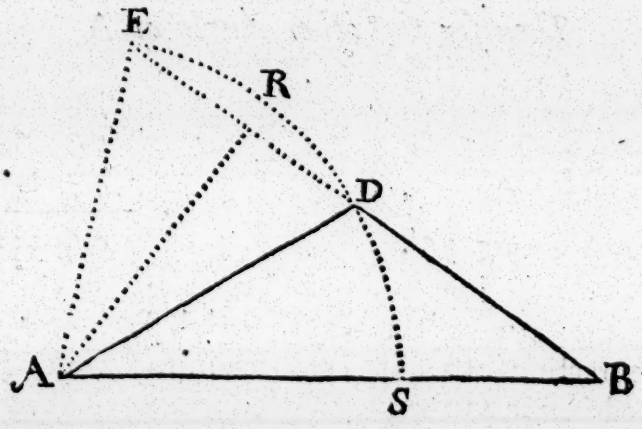
Laſtly, for the other Angles.

As DA 244 leagues, *co. ar.*	7.61261	This Weſtermoſt Ship ſailed E S E 6 *deg.* 59′ Southerly.
Is to *ſ.* B 36 *deg.* 53′;	9.77827	
So is BD 200 leagues,	2.30103	
To *ſ.* A 29 *deg.* 29′.	9.69191	

The two little *Angles* being found, ſubſtract them from 180 degrees, and the remainder is the *Angle* ADB 113 *deg.* 38′.

But in this and the Caſe two, you may ask why the longeſt ſide ſhould be the true *Baſe*, and not as well one of the ſhorteſt ſides.

If therefore in the Triangle ABD we take DB for the true *Baſe*, I'll lay down the Triangle ADB, as before (in the fourth Caſe) onely I'll draw the *Baſe* BD forth to E, as in the following Figure;



then if you take the ſhorteſt of the other two ſides AD, and deſcribe

the Arch E R D S, it cuts off S B for the difference of the two sides. B E will be the *alternate Base*; and if you let fall the Perpendicular A R (upon the *alternate Base* E B) then D R will be equal to R E. I'll say then,

As D B the true *Base* 200 paces or leagues, *co. ar.*		7.69896
Is to D A + A B, the sum of the other two sides 616;		2.78958
So is the difference of those two sides S B 128,		2.10721
To the *alternate Base* B E.	394	2.59575
From which, if I substract D B,	200	
The remainder is D E;	194	
The half of which is R D.	097	
Which being added to D B,	200	
It makes B R	297	

And now I have B R 297, and B A 372, the two sides of the right angled Triangle B R A, to find the *Angle* of the Eastermost Ships Course, or the *Angle* at B.

I say then, As A B 372, *co. ar.*	7.42945
Is to *Radius* or *s.* A R B 90 *deg.*	
So is R B 297	2.47275
To *s. co.* R A B, which is *s.* B 37 *deg.* 02′	9.90220

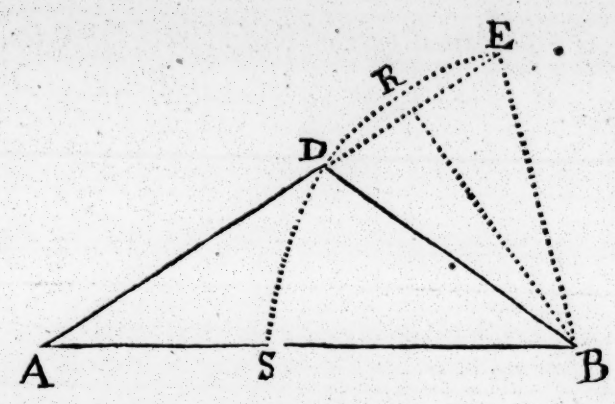
Then for the other Angle at A.

As D A 244 *co. ar.*	7.61261
Is to *s.* B 37 *deg.* 02′;	9.77979
So is D B 200,	2.30103
To *s.* A 29 *deg.* 35′.	9.69343

The difference between the *Angles* found, here and before, is by reason of the fraction of a unite omitted in the working of the sides, as I have noted before in the finding of the sides all along.

The

The like may be done, if you make A D the true *Baſe*, as in this Triangle following.



I extend the true *Baſe* to E, and with the length of the ſhorteſt of the other two ſides, I deſcribe the Arch S D R E, which cuts off S A for the difference between the two ſides (B A and B D) and makes A E the *alternate Baſe*.

I ſay then,

As the *true Baſe* A D 244,
Is to the ſum of A B + B D 572 ;
So is the difference of them two ſides S A.
To the *alternate Baſe* A E.

Now if you ſubſtract A D the *true Baſe* from the *alternate Baſe* A E, the remainder will be D E ; the half of which (namely D R) added to the *true Baſe*, makes A R.

Thus then you have A R and A B (in the right angled Triangle A D B) to find the Angle at A, or the Weſtermoſt Ships Courſe ; which being found, you have the three ſides of the Triangle, and an Angle, to find the other Angles. I leave the practice of it to your own Genious.

There be divers things wrought by theſe Triangles ; as, platting of Land at Sea, as one ſails by it ; and aſhore it's uſeful in ſurveying, and ſeveral ways : but thoſe things are largely treated of already by others, and therefore I'll omit them.

I propoſe to ſhew how to take the abſolute *Logarithm*, *Sine*, or *Tangent*, anſwering to a number ; that ſo, if occaſion require, you may find the abſolute minute of a degree you ſeek for in an Angle, or otherwiſe,

wise. This I refer you to my *Description of the Use of those Tables*, just before them, at the end of the *Book*.

So much for the Doctrinal part of Right lined Triangles, both Right *and* Oblique *angled; and the Application of them to* Plain Sailing.

CHAP. XXVIII.

Here followeth

A TABLE

OF

MERIDIONAL PARTS,

To work by

Mercator's Projection.

Min.	Latit. 00 *d.*	Latit. 01 *d.*	Latit. 02 *d.*	Latit. 03 *d.*	Latit. 04 *d.*	Latit. 05 *d.*	Latit. 06 *d.*	Latit. 07 *d.*	Min.
0	0	60	120	180	240	300	361	421	0
2	2	62	122	182	242	302	363	423	2
4	4	64	124	184	244	304	365	425	4
6	6	66	126	186	246	306	367	427	6
8	8	68	128	188	248	308	369	429	8
10	10	70	130	190	250	310	371	431	10
12	12	72	132	192	252	312	373	433	12
14	14	74	134	194	254	314	375	435	14
16	16	76	136	196	256	316	377	437	16
18	18	78	138	198	258	318	379	439	18
20	20	80	140	200	260	320	381	441	20
22	22	82	142	202	262	322	383	443	22
24	24	84	144	204	264	324	385	445	24
26	26	86	146	206	266	326	387	447	26
28	28	88	148	208	268	328	389	449	28
30	30	90	150	210	270	330	391	451	30
32	32	92	152	212	272	332	393	453	32
34	34	94	154	214	274	334	395	455	34
36	36	96	156	216	276	336	397	457	36
38	38	98	158	218	278	338	399	459	38
40	40	100	160	220	280	340	401	461	40
42	42	102	162	222	282	342	403	463	42
44	44	104	164	224	284	344	405	465	44
46	46	106	166	226	286	346	407	467	46
48	48	108	168	228	288	348	409	469	48
50	50	110	170	230	290	350	411	471	50
52	52	112	172	232	292	352	413	473	52
54	54	114	174	234	294	354	415	475	54
56	56	116	176	236	296	356	417	477	56
58	58	118	178	238	298	358	419	479	58
60	60	120	180	240	300	361	421	481	60
	Meri. parts.	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri parts.*	

Min.	Latit. 08 d.	Latit. 09 d.	Latit. 10 d.	Latit. 11 d.	Latit. 12 d.	Latit. 13 d.	Latit. 14 d.	Latit. 15 d.	Min.
0	481	542	603	664	725	786	848	910	0
2	483	544	605	666	727	789	850	912	2
4	485	546	607	668	729	791	852	914	4
6	488	548	609	670	731	793	854	917	6
8	490	550	611	672	733	795	857	919	8
10	492	552	613	674	735	797	858	921	10
12	494	554	615	676	737	799	860	923	12
14	496	556	617	678	739	801	862	925	14
16	498	558	619	680	742	803	864	927	16
18	500	560	621	682	744	805	866	929	18
20	502	562	623	684	745	807	869	931	20
22	504	564	625	686	747	809	871	933	22
24	506	566	627	688	749	811	873	935	24
26	508	568	629	690	751	813	875	937	26
28	510	570	631	693	753	815	877	939	28
30	512	573	633	694	755	817	879	941	30
32	514	575	635	697	758	819	881	943	32
34	516	577	637	699	760	821	883	945	34
36	518	579	640	701	762	824	885	948	36
38	520	581	642	703	764	826	888	951	38
40	522	583	644	705	766	828	890	953	40
42	524	585	646	707	768	830	892	955	42
44	526	587	648	709	770	832	894	957	44
46	528	589	650	711	772	834	896	959	46
48	530	591	652	713	774	836	898	961	48
50	532	593	654	715	776	838	900	963	50
52	534	595	656	717	778	840	902	965	52
54	536	597	658	719	780	842	904	967	54
56	538	599	660	721	782	844	906	969	56
58	540	601	662	723	784	846	908	971	58
60	542	603	664	725	786	848	910	973	60
	Meri. parts.	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	

Min.	Latit. 16 d.	Latit. 17 d.	Latit. 18 d.	Latit. 19 d.	Latit. 20 d.	Latit. 21 d.	Latit. 22 d.	Latit. 23 d.	Min.
0	973	1035	1098	1161	1225	1289	1354	1419	0
2	975	1037	1100	1163	1227	1291	1356	1421	2
4	977	1039	1102	1166	1229	1293	1358	1423	4
6	979	1041	1104	1168	1232	1295	1360	1425	6
8	981	1044	1106	1170	1234	1297	1362	1427	8
10	983	1046	1109	1172	1237	1300	1364	1429	10
12	985	1048	1111	1174	1239	1302	1366	1431	12
14	987	1050	1113	1176	1241	1304	1369	1434	14
16	989	1052	1115	1178	1243	1306	1371	1436	16
18	991	1054	1117	1180	1245	1308	1373	1438	18
20	993	1056	1119	1183	1247	1310	1375	1440	20
22	995	1058	1121	1185	1249	1312	1377	1442	22
24	998	1060	1123	1187	1251	1314	1379	1445	24
26	1000	1062	1125	1189	1253	1316	1382	1447	26
28	1002	1064	1128	1191	1255	1318	1384	1449	28
30	1004	1066	1130	1193	1257	1320	1386	1451	30
32	1006	1068	1132	1195	1259	1323	1388	1453	32
34	1008	1070	1134	1197	1261	1325	1390	1456	34
36	1010	1072	1136	1199	1263	1328	1392	1459	36
38	1012	1074	1138	1202	1266	1330	1394	1460	38
40	1014	1076	1140	1204	1268	1332	1396	1462	40
42	1016	1078	1142	1206	1270	1334	1398	1465	42
44	1018	1080	1144	1208	1272	1336	1401	1467	44
46	1020	1083	1147	1210	1274	1338	1403	1469	46
48	1023	1085	1149	1212	1276	1341	1405	1471	48
50	1025	1087	1151	1214	1278	1343	1407	1473	50
52	1027	1089	1153	1216	1281	1345	1410	1476	52
54	1029	1092	1155	1219	1283	1347	1412	1478	54
56	1031	1094	1157	1221	1285	1349	1414	1480	56
58	1033	1096	1159	1223	1287	1351	1416	1482	58
60	1035	1098	1161	1225	1289	1354	1419	1484	60
	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	

Min.	Latit. 24 d.	Latit. 25 d.	Latit. 26 d.	Latit. 27 d.	Latit. 28 d.	Latit. 29 d.	Latit. 30 d.	Latit. 31 d.	Min.
0	1484	1550	1617	1683	1751	1818	1887	1958	0
2	1486	1552	1619	1686	1753	1821	1890	1960	2
4	1488	1554	1621	1688	1756	1823	1892	1962	4
6	1491	1556	1623	1690	1758	1825	1894	1965	6
8	1493	1559	1625	1692	1760	1827	1898	1967	8
10	1495	1561	1627	1694	1763	1830	1900	1969	10
12	1497	1563	1630	1696	1765	1832	1902	1972	12
14	1499	1565	1632	1699	1767	1834	1904	1975	14
16	1502	1567	1634	1701	1770	1838	1906	1978	16
18	1504	1569	1636	1703	1772	1840	1908	1980	18
20	1506	1572	1639	1705	1774	1842	1910	1982	20
22	1508	1574	1641	1707	1776	1845	1914	1984	22
24	1510	1576	1643	1710	1778	1847	1916	1986	24
26	1512	1578	1645	1713	1781	1849	1918	1988	26
28	1514	1580	1648	1715	1784	1851	1921	1991	28
30	1517	1583	1650	1717	1786	1854	1923	1993	30
32	1519	1586	1652	1719	1788	1855	1925	1995	32
34	1521	1588	1654	1721	1790	1857	1926	1998	34
36	1523	1590	1657	1724	1792	1860	1928	2000	36
38	1525	1593	1659	1726	1794	1862	1931	2002	38
40	1528	1595	1661	1728	1796	1864	1934	2004	40
42	1530	1597	1663	1730	1798	1866	1936	2007	42
44	1532	1599	1665	1733	1801	1869	1939	2009	44
46	1534	1601	1668	1735	1803	1871	1941	2012	46
48	1536	1604	1670	1737	1805	1873	1943	2014	48
50	1539	1605	1672	1739	1807	1876	1946	2017	50
52	1541	1607	1674	1740	1810	1878	1948	2019	52
54	1543	1610	1677	1742	1812	1880	1951	2021	54
56	1545	1613	1679	1745	1814	1883	1953	2023	56
58	1548	1615	1681	1747	1816	1885	1955	2025	58
60	1550	1617	1683	1751	1818	1887	1958	2028	60
	Meri. parts.	*Meri. parts.*	*Meri. parts.*	*Meri parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	

Min.	Latit. 32 d.	Latit. 33 d.	Latit. 34 d.	Latit. 35 d.	Latit. 36 d.	Latit. 37 d.	Latit. 38 d.	Latit. 39 d.	Min.
0	2028	2101	2171	2244	2318	2392	2466	2544	0
2	2030	2103	2174	2246	2320	2395	2471	2548	2
4	2033	2105	2176	2249	2323	2397	2473	2551	4
6	2035	2108	2178	2251	2326	2400	2476	255	6
8	2038	2110	2181	2253	2329	2402	2478	2555	8
10	2040	2112	2183	2255	2331	2404	2481	2558	10
12	2042	2114	2186	2258	2333	2407	2483	2561	12
14	2044	2116	2188	2261	2335	2409	2486	2563	14
16	2047	2118	2191	2264	2337	2413	2488	2566	16
18	2049	2120	2193	2266	2339	2415	2491	2568	18
20	2052	2122	2195	2269	2342	2417	2493	2571	20
22	2054	2125	2197	2271	2345	2420	2496	2573	22
24	2056	2127	2199	2274	2347	2422	2498	2576	24
26	2059	2130	2202	2276	2349	2425	2500	2578	26
28	2061	2133	2204	2278	2352	2427	2503	2581	28
30	2063	2134	2207	2281	2355	2430	2506	2584	30
32	2066	2136	2209	2283	2358	2433	2509	2586	32
34	2068	2139	2212	2286	2360	2435	2512	2589	34
36	2071	2141	2214	2288	2362	2438	2514	2592	36
38	2073	2144	2216	2291	2365	2440	2517	2595	38
40	2076	2146	2219	2293	2368	2442	2519	2597	40
42	2078	2149	2222	2296	2370	2444	2521	2599	42
44	2080	2152	2224	2298	2372	2446	2523	2602	44
46	2083	2154	2227	2301	2375	2449	2526	2604	46
48	2086	2157	2229	2303	2377	2452	2528	2607	48
50	2088	2159	2232	2306	2380	2455	2531	2610	50
52	2090	2162	2234	2308	2382	2458	2533	2612	52
54	2092	2164	2237	2310	2385	2461	2536	2615	54
56	2095	2166	2239	2313	2387	2463	2538	2617	56
58	2097	2169	2242	2315	2390	2466	2541	2620	58
60	2099	2171	2244	2318	2392	2468	2544	2623	60
	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	

Min.	Latit. 40 d.	Latit. 41 d.	Latit. 42 d.	Latit. 43 d	Latit 44 d	La it. 45 d.	Latit. 46 d.	Latit. 47 d.	Min.
0	2623	2702	2782	2863	2946	3030	3116	3203	0
2	2625	2704	2784	2866	2949	3033	3118	3206	2
4	2628	2707	2787	2869	2951	3036	3121	3209	4
6	2630	2710	2790	2871	2954	3038	3124	3212	6
8	2633	2712	2792	2874	2957	3041	3127	3214	8
10	2636	2715	2795	2877	2960	3044	3130	3217	10
12	2638	2717	2798	2880	2963	3047	3133	3220	12
14	2641	2720	2801	2882	2965	3050	3136	3223	14
16	2644	2723	2803	2885	2968	3053	3139	3226	16
18	2646	2725	2806	2888	2971	3055	3142	3229	18
20	2649	2728	2809	2890	2974	3058	3144	3232	20
22	2651	2731	2811	2893	2976	3061	3147	3235	22
24	2654	2733	2814	2896	2979	3064	3150	3238	24
26	2657	2736	2817	2899	2982	3067	3153	3241	26
28	2659	2739	2820	2902	2985	3070	3156	3244	28
30	2662	2741	2822	2904	2988	3073	3159	3247	30
32	2665	2744	2825	2907	2990	3075	3162	3250	32
34	2667	2747	2828	2910	2993	3078	3165	3253	34
36	2669	2749	2830	2913	2996	3081	3168	3256	36
38	2671	2752	2833	2915	2999	3084	3171	3259	38
40	2675	2755	2836	2918	3002	3087	3173	3262	40
42	2678	2758	2839	2921	3005	3090	3176	3265	42
44	2680	2760	2841	2924	3007	3093	3179	3268	44
46	2683	2763	2844	2926	3010	3095	3182	3271	46
48	2686	2766	2847	2929	3013	3098	3185	3274	48
50	2688	2768	2849	2931	3016	3101	3188	3277	50
52	2691	2771	2852	2935	3019	3104	3191	3280	52
54	2694	2774	2855	2937	3022	3107	3194	3283	54
56	2696	2776	2858	2940	3024	3110	3197	3286	56
58	2699	2779	2860	2943	3027	3113	3200	3289	58
60	2702	2782	2863	2946	3030	3116	3203	3292	60
	Meri. parts.	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	*Meri. parts.*	

Min.	Latit. 48 d.	Latit. 49 d.	Latit. 50 d.	Latit. 51 d.	Latit. 52 d.	Latit. 53 d.	Latit. 54 d.	Latit. 55 d.	Min.
0	3292	3382	3475	3569	3665	3765	3865	3968	0
2	3295	3385	3478	3572	3669	3769	3868	3972	2
4	3298	3388	3481	3575	3672	3772	3872	3975	4
6	3301	3391	3484	3578	3675	3775	3875	3979	6
8	3304	3394	3487	3582	3678	3778	3878	3982	8
10	3307	3397	3490	3585	3682	3780	3882	3986	10
12	3310	3400	3493	3588	3685	3783	3885	3989	12
14	3313	3403	3496	3591	3688	3787	3889	3993	14
16	3316	3407	3499	3594	3691	3791	3892	3996	16
18	3319	3410	3503	3598	3695	3794	3895	4000	18
20	3322	3413	3506	3601	3698	3797	3899	4003	20
22	3325	3416	3509	3604	3701	3801	3902	4006	22
24	3328	3419	3512	3607	3705	3804	3906	4010	24
26	3331	3422	3515	3610	3708	3807	3909	4014	26
28	3334	3425	3518	3614	3711	3811	3912	4017	28
30	3337	3428	3521	3617	3714	3814	3916	4021	30
32	3340	3431	3525	3620	3718	3817	3920	4024	32
34	3343	3434	3528	3623	3721	3821	3923	4028	34
36	3346	3437	3531	3626	3724	3824	3926	4031	36
38	3349	3440	3534	3630	3728	3827	3930	4035	38
40	3352	3443	3537	3633	3731	3831	3933	4038	40
42	3355	3447	3540	3636	3734	3834	3937	4042	42
44	3358	3449	3543	3639	3737	3838	3940	4046	44
46	3361	3453	3547	3643	3741	3841	3944	4049	46
48	3364	3456	3550	3646	3744	3844	3947	4053	48
50	3367	3459	3553	3649	3747	3848	3951	4056	50
52	3370	3462	3556	3652	3751	3851	3954	4060	52
54	3373	3465	3559	3656	3754	3855	3958	4063	54
56	3376	3468	3562	3659	3757	3858	3961	4067	56
58	3379	3471	3566	3662	3761	3861	3965	4070	58
60	3382	3475	3569	3665	3765	3865	3968	4074	60
	Meri. parts.	Meri. parts.	Meri. parts.	Meri parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	

Min.	Latit. 56 d.	Latit. 57 d.	Latit. 58 d.	Latit. 59 d.	Latit. 60 d.	Latit. 61 d	Latit. 62	Latit. 63 d.	Min.
0	4074	4183	4294	4409	4528	4649	4775	4905	0
2	4078	4186	4298	4413	4532	4654	4780	4, 10	2
4	4081	4190	4302	4417	4536	4658	4784	4914	4
6	4085	4194	4306	4421	4540	4662	4788	4919	6
8	4088	4197	4310	4425	4544	4666	4792	4923	8
10	4092	4201	4313	4429	4548	4670	4797	4927	10
12	4097	4205	4317	4433	4552	4674	4801	4932	12
14	4100	4209	4321	4437	4556	4678	4805	4936	14
16	4103	4212	4325	4441	4560	4683	4809	4941	16
18	4106	4216	4329	4444	4564	4687	4814	4945	18
20	4110	4220	4332	4448	4568	4691	4818	4950	20
22	4114	4223	4336	4452	4572	4695	4822	4954	22
24	4117	4227	4340	4456	4576	4699	4827	4959	24
26	4121	4231	4344	4460	4580	4704	4831	4963	26
28	4124	4235	4348	4464	4584	4708	4835	4967	28
30	4128	4238	4352	4468	4588	4712	4840	4972	30
32	4132	4242	4355	4472	4592	4716	4844	4976	32
34	4135	4246	4359	4476	4596	4720	4848	4981	34
36	4139	4249	4363	4480	4600	4724	4853	4985	36
38	4143	4253	4367	4484	4604	4729	4857	4990	38
40	4146	4257	4371	4488	4608	4733	4861	4994	40
42	4150	4261	4375	4492	4613	4737	4866	4999	42
44	4154	4264	4378	4496	4617	4741	4870	5003	44
46	4157	4268	4382	4500	4621	4746	4875	5008	46
48	4161	4272	4386	4504	4625	4750	4880	5012	48
50	4164	4276	4390	4508	4629	4754	4883	5017	50
52	4168	4279	4394	4512	4633	4758	4888	5022	52
54	4172	4283	4398	4516	4637	4762	4892	5026	54
56	4175	4287	4402	4520	4641	4767	4896	5031	56
58	4179	4291	4405	4524	4645	4771	4901	5035	58
60	4183	4294	4409	4528	4649	4775	4905	5040	60
	Meri. parts.	Meri. parts	Meri. parts.	Meri parts.	Meri parts.	Meri. parts.	Meri. parts	Meri. parts.	

Min.	Latit. 64 d.	Latit. 65 d	Latit. 66 d.	Latit. 67 d.	Latit. 68 d.	Latit. 69 d.	Latit. 70 d.	Latit. 71 d.	Min.
0	5040	5179	5324	5474	5631	5795	5967	6146	0
2	5044	5184	5329	5480	5637	5801	5972	6153	2
4	5049	5189	5334	5485	5642	5806	5978	6159	4
6	5053	5193	5339	5490	5647	5812	5984	6165	6
8	5058	5198	5344	5495	5653	5818	5990	6171	8
10	5063	5203	5349	5500	5658	5823	5996	6177	10
12	5067	5208	5354	5505	5664	5829	6002	6183	12
14	5072	5212	5359	5511	5669	5834	6008	6190	14
16	5076	5217	5364	5516	5674	5840	6014	6196	16
18	5081	5222	5368	5521	5680	5846	6020	6202	18
20	5086	5227	5373	5526	5685	5851	6026	6208	20
22	5090	5232	5378	5531	5691	5857	6032	6215	22
24	5095	5236	5383	5537	5696	5863	6038	6221	24
26	5100	5241	5388	5542	5701	5868	6043	6227	26
28	5104	5246	5393	5547	5707	5874	6049	6234	28
30	5109	5251	5398	5552	5712	5880	6055	6240	30
32	5114	5256	5403	5557	5718	5886	6061	6246	32
34	5118	5261	5409	5563	5723	5891	6067	6252	34
36	5123	5265	5414	5568	5729	5897	6073	6259	36
38	5127	5270	5419	5573	5734	5903	6079	6265	38
40	5132	5275	5424	5578	5740	5909	6085	6271	40
42	5137	5280	5429	5584	5745	5914	6092	6278	42
44	5142	5285	5434	5589	5751	5920	6098	6284	44
46	5146	5290	5439	5594	5756	5926	6104	6291	46
48	5151	5295	5444	5599	5762	5932	6110	6297	48
50	5156	5299	5449	5605	5767	5937	6116	6303	50
52	5160	5304	5454	5610	5773	5943	6122	6310	52
54	5165	5309	5459	5615	5778	5949	6128	6316	54
56	5170	5313	5464	5621	5784	5955	6134	6323	56
58	5174	5319	5469	5626	5790	5961	6140	6329	58
60	5179	5324	5474	5631	5795	5967	6146	6336	60
	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	

Min.	Latit. 72 d.	Latit. 73 d.	Latit. 74 d.	Latit. 75 d.	Latit. 76 d.	Latit. 77 d.	Latit. 78 d.	Latit. 79 d.	Latit. 80 d.	Min.
0	6336	6535	6747	6971	7211	7469	7740	8047	8377	0
2	6342	6542	6754	6979	7220	7478	7756	8058	8389	2
4	6349	6549	6761	6987	7228	7486	7765	8069	8400	4
6	6355	6556	6769	6995	7236	7495	7775	8079	8412	6
8	6362	6563	6776	7003	7245	7504	7785	8090	8424	8
10	6368	6570	6783	7010	7253	7513	7795	8100	8435	10
12	6375	6577	6791	7018	7261	7522	7804	8111	8447	12
14	6381	6584	6798	7026	7270	7531	7814	8122	8459	14
16	6388	6590	6805	7034	7278	7540	7824	8132	8471	16
18	6394	6597	6813	7042	7287	7550	7834	8143	8483	18
20	6401	6605	6820	7050	7295	7559	7844	8154	8494	20
22	6408	6611	6827	7058	7303	7568	7854	8165	8506	22
24	6414	6618	6835	7065	7312	7577	7864	8176	8518	24
26	6421	6625	6842	7073	7321	7586	7875	8187	8530	26
28	6427	6632	6850	7081	7329	7595	7884	8198	8542	28
30	6434	6639	6857	7089	7338	7605	7894	8208	8555	30
32	6441	6647	6865	7097	7346	7614	7904	8219	8567	32
34	6447	6654	6872	7105	7355	7623	7914	8231	8579	34
36	6454	6661	6880	7113	7363	7632	7924	8242	8591	36
38	6461	6668	6887	7121	7372	7642	7934	8253	8603	38
40	6468	6675	6895	7130	7381	7651	7944	8264	8616	40
42	6474	6682	6903	7138	7389	7661	7954	8275	8628	42
44	6481	6689	6910	7146	7398	7670	7965	8286	8641	44
46	6488	6696	6918	7154	7407	7679	7975	8297	8653	46
48	6494	6703	6925	7162	7416	7687	7985	830	8665	48
50	6501	6711	6933	7170	7424	7698	7995	8320	8678	50
52	6508	6718	6941	7178	7433	7708	8006	8331	8691	52
54	6515	6725	6948	7187	7442	7717	8016	8343	8703	54
56	6522	6732	6956	7195	7451	7727	8026	8354	8716	56
58	6528	6739	6964	7203	7459	7737	8037	8366	8729	58
60	6535	6747	6971	7211	7469	7746	8047	8377	8741	60
	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	Meri. parts.	

The Uſe of theſe Tables of Meridional Parts.

THe Parts expreſſed here, are *Meridional Parts of Latitude*; and they are ſuch, that 60 of them is a degree of Longitude in that Latitude: ſo that if a man ſails out of one Latitude into another, the parts contained between thoſe Latitudes, are in the ſame meaſure that the minutes of Longitude are. Their onely uſe then is, to find the Meridional Parts contained between any two given Latitudes, and with that to make a ſide of a Triangle, whereby to find the difference of Longitude.

CASE 1.

To find the Meridional Parts contained between two Latitudes.

Queſt. 1. *Admit I ſailed from the Latitude of* 50 deg. 08′, *into the Latitude of* 49 *deg.* 2′; *I demand the Meridional Parts contained between theſe Latitudes?*

I Look at the head of the Tables for Latitude 50 *deg.* and in the little Colume on the left hand or on the right hand (which is neareſt) for 8 minutes, and I find under 50 *deg.* and againſt 8′ 3487
Alſo under 49 *deg.* and againſt 2′ 3385
Which being ſubſtracted from the other, the remainder is the difference of Latitude in parts. 0102

This difference of Latitude in parts I uſe as a common ſide of difference of Latitude, to find the difference of Longitude by.

Theſe Tables are calculated but to every two minutes of a degree, which is near enough: for it falls to be upon a number of minutes that is not in the Tables, it is but taking half the difference between that and the next.

For Example.

Admit I would know the Meridional part anſwering to 50 deg. 7′.

I look for 50 *deg.* 6 *min.* and find 3484
I look for 50 *deg.* 8 *min.* and find 3487

The difference between theſe is 3

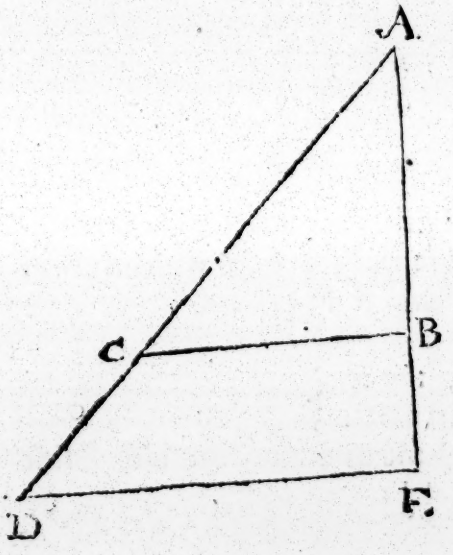
The half difference is 1 ½

This 1 ½ adde to the Meridional part answering to 50 *deg.* 6 *min.* and it gives me 3485½ for the Meridional part answering to 50 *deg.* 7 *min.* (the half is inconsiderable); but this you do by onely looking to the parts, and adding one, or substracting, according as you desire.

CASE 2.

The Latitude of two places, and the difference of Longitude between them given, to find the Course and distance run.

Quest. 2. *Admit there be two places, one in the Latitude of* 51 deg. 10′, *the other in the Latitude of* 48 deg. 00′, *and the Southermost of these places is to the Westwards of the Northermost* 4 deg. 38′; *I demand their bearing and distance one from the other.*



TAke the Meridional part answering to each Latitude, and substract them one from the other; and so I have the difference of latitude in parts. Now these parts being (as I have said before) such parts as 60 of them make a degree of Longitude, I have my difference of Latitude in parts given, and my difference of Longitude in minutes (or such parts) whereby I lay down the Triangle A D E, as I would do a common Question, where difference of Latitude and Departure is given, and so find the Course, thus.

Example.

Latitude	51 *deg.* 10′	Merid. parts	3585
Latitude	48 *deg.* 00′	Merid. parts.	3292
The Meridional parts contained between these Latitudes, is			293
The difference of Longitude in parts or minutes, is			278

I say then in the Triangle A E D,

As the difference of Latitude in parts, A E 293 *co. ar.*	7.53313
Is to *Radius* or *s.* E 90 *deg.* 00′ ;	
So is the difference of Longitude in parts, E D 278′,	2.44404
To the *Tangent* of the Course *t.* A 43 *deg.* 29′.	9.97717

Thus then you have the Course given, namely the Angle at A 43 *deg.* 29′, and the two Latitudes ; (substract them one from the other, and the difference convert into miles) and set it off from A, the difference of Latitude is A B 190 miles. To find the distance run A C, it falls under the third Case.

For the distance A C.

As s. co. A 43 *deg.* 29′ *co. ar.*	9.86068
Is to A B 190 miles ;	2.27875
So is *Radius* B 90 *deg.*	
To C A 262 minutes.	2.41806

The distance run is thus found then to be 262 miles neareſt.

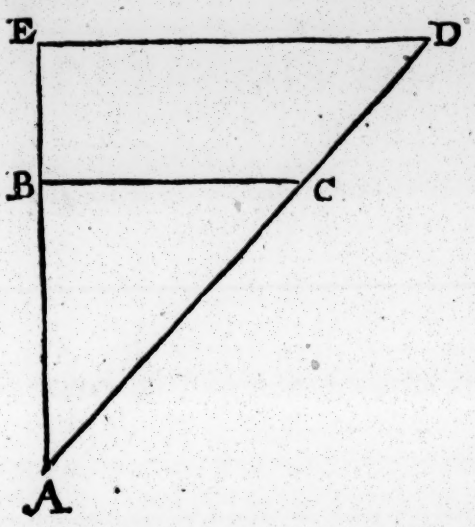
This might be done by *Gunter*'s Ruler, as in Case the fifth and Case the third; but surely no man can be ignorant of that Ruler that knows how to work by these Tables.

CASE 3.

The Latitudes of two places, and their distance given, to find their bearing and difference of Longitude.

Queſt. 3. *Admit there be a place in the Latitude of* 48 deg. 00′, *another in the Latitude of* 51 deg. 10′, *and to the Eastwards of the former* 262 *miles*; *I demand their bearing, and the difference of Longitude between them.*

IN this Question you have the two Latitudes given; so that by substracting them one from the other, you have the difference of Latitude ; (reduce it into miles) also you have the distance run 260 miles; so that you may lay down the Triangle A B C, a common Tri-



angle, and in it you have given A B, and A C, to find the Course, which is the Angle at A: it falls under the first Case of Right lined right angled Triangles.

The Course being found, in the next place take the *Meridional Parts* contained between the two Latitudes, and with them Parts and the Course lay down the Triangle A E D, as a common Triangle is laid, that hath the Course and difference of Latitude given; and so you have the difference of Latitude in parts given A E, and the Course or Angle at A, to find the difference of Longitude E D.

Example.

	deg.	*min.*	
The one Latitude is	51	10	
The other Latitude is	48	00	
The difference of Latitude is B A	03	10	or 190 miles.
A C the distance of the places is given in the Question			262 miles.

For the Course A.

As the distance A C 262 miles, *co. ar.*	7.58169
Is to *Radius* or *s.* B 90 *deg.*	
So is the difference of Latitude B A 190 miles,	2.27875
To *s. co.* A C B 43 *deg.* 29′.	9.86044

The bearing of the Northermost Port is North East by North 9 *deg.* 44′ Easterly.

Next, for the difference of Longitude E D.

I look for the Meridional parts contained between the two given Latitudes, and having found it, (as here to be 293) with this, and the Course before found, I say,

As

As *s. co.* A (which is *s.* A D E) 43 *deg.* 29′ *co. ar.*	0.13931
Is to the difference of Latitude in parts, A E 293 paces;	2.46686
So is *s.* A 43 *deg.* 29′,	9.83767
To the difference of Longitude E D 278′ or parts.	2.44384

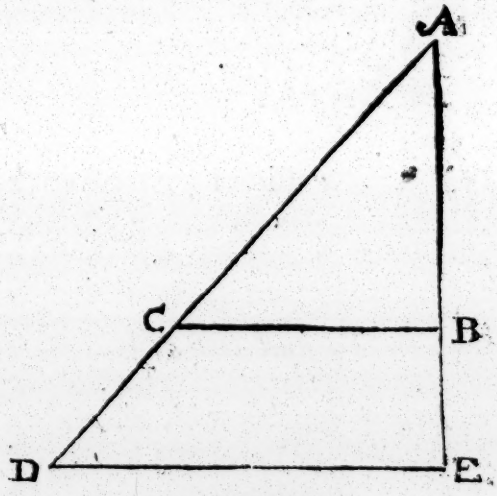
Which is 4 *deg.* 38′. The like for any other of this kind.

CASE 4.

The Latitude of two places given, with the bearing of them one from the other, to find the distance between them, and the difference of Longitude.

Queſt. 4. *Admit there be a place in the Latitude of* 51 deg. 10′, *another in Latitude* 48 deg. 00′ *(both North Latitude) and that the Southermoſt place bears South* 43 deg. 29′ *Weſterly from the other; I demand the diſtance and difference of Longitude between them?*

HEre you have the two Latitudes given, and the Courſe whereby you may lay down the Triangle A C B, a common Triangle, and you have given in it the Angle at A 43 *deg.* 29′ the ſide A B the difference of Latitude 190 miles; whereby I find the diſtance.



For A C.

As *s. co.* A 43 *deg.* 29′, *co. ar.*	0.13931
Is to A B 190 miles;	2.27875
So is *Radius* or *s.* A B C 90 *deg.*	
To C A 262 leagues,	2.41806

The diſtance between the two places.

For the difference of Longitude D E.

I look for the Meridional parts contained between the two Latitudes, and with them and the Courſe given in the Queſtion, I lay down the Triangle

Triangle A E D (as in the Question before this) and in it I have the difference of Latitude in parts E A given me, and the Angle at A 43 *deg.* 29′, to find the difference of Longitude E D.

I say then,

As *s.* *co.* A 43 *deg.* 29′, *co.* *ar.*	0.13931
Is to A E 293 parts;	2.46686
So is *s.* A 43 *deg.* 29′	9.83767
To D E the difference of Longitude 278′	2.44384

Or 4 *deg.* 38′ required.

CASE 5.

The Rumb, the difference of Longitude, and one Latitude given, to find the other Latitude and the distance.

Quest. 5. *Admit I set from a place that is in North Latitude* 51 deg. 10′, *and sail South West by South* 9 deg. 44′ *Westerly, that is, South* 43 deg. 29′ *Westerly, till I have West Longitude from the place I set* 4 deg. 38′ *or* 278′; *I demand what Latitude I am in, and my distance from the place I set.*

IN this Question I have given the Angles of the Triangle A E D, and the difference of Longitude E D; whereby I lay down the Triangle A D E, as a common Triangle, and say,

To find the difference of Latitude in parts A E.

As *s.* A 43 *deg.* 29′, *co.* *ar.*	0.16232
Is to the difference of Longitude in parts D E 278;	2.44404
So is *s.* *co.* A 43 *deg.* 29′	9.86968
To A E the difference of Latitude in parts 293	2.46704

Now this difference of Latitude in parts being found, I seek in the Table of *Meridional Parts*, what answers to the Latitude given me in the Question 51 *deg.* 10′, and I find 3585
From which I substract the difference of Lat. found in parts 0293

The remainder is 3292

I'll look in the Tables of *Meridional Parts* for 3292, and over it I find

find Latitude 48 *deg.* and against it in the little Colume of minutes; so I conclude the other Latitude is 48 *deg.* 00′: The reason why I substracted the Meridional parts found, was, because I sailed to the Southwards into a less Latitude.

We have now both Latitudes given; so that if we substract the lesser from the greater, we have the difference of Latitude 3 *deg.* 10′, or 190 miles: with this difference of Latitude, and the Course given in the Question, we will lay down the common Triangle A C B, and so in it we have given the Angle at A 43 *deg.* 29′, and the side A B the difference of Latitude in miles, to find the distance run A C; so that this falls under the second Case of right lined right angled Triangles, thus:

As *s. co.* A the Course 43 *deg.* 29′, *co. ar.*	0.13931
Is to the difference of Latitude in miles 190 miles;	2.27875
So is *Radius*	
To the distance run A C 262 miles.	2.41706

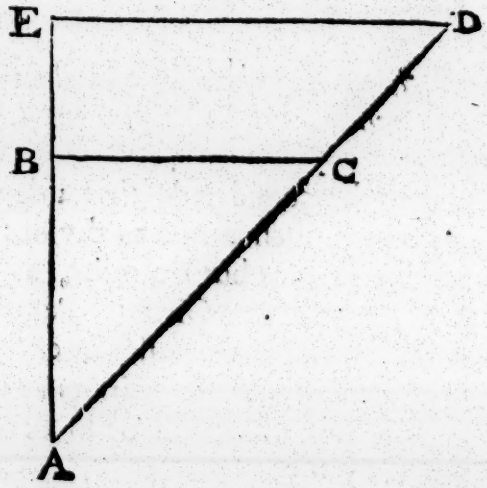
CASE 6.

The Course, the distance, and one Latitude given, to find the other Latitude, and the difference of Longitude.

Quest. 6. *Admit I set from* 48 deg. *North Latitude, and sail North Easterly* 43 deg. 29′, 262 *miles; I demand what Latitude I am in, and my departure from my Meridian, with the difference of Longitude?*

HEre I have the Course and distance run given, whereby I may lay down the common Triangle A B C; which being done, I have A C given 262 miles, and the Angle at A 43 *deg.* 29′, to find the difference of Latitude B A. I'll say then,

As *Radius* or A B C 90 *deg.*	
Is to C A 262 miles;	2.41830
So is *s. co.* A 43 *deg.* 29′	9.86068
To B A 190 miles.	2.27898



This

This difference of Latitude 190 miles (which is 3 *deg.* 10′) added to the Latitude, I ſet from (48 *deg.* 00′) gives the Latitude I am in 51 *deg.* 10′.

Laſtly, I have now the Courſe given, and the two Latitudes, to find the difference of Longitude.

See what number of Meridional parts is contained between the two Latitudes, and I find 292; with that and the Courſe I lay down the Triangle A E D (as I have formerly ſhewed) and (as I would do a common Triangle) where the difference of Latitude in miles, and the Courſe is given.

In which Triangle I have the difference of Latitude in parts A E 293 and the Courſe A 43 *deg.* 29′ given.

To find the difference of Longitude E D, *as in the fourth Caſe of this Sailing.*

As *s. co.* A 43 *deg.* 29′, *co. ar.*	0.13931
Is to A E 293 parts;	2.46686
So is *s.* A 43 *deg.* 29′	9.83781
To E D 278 parts or minutes of Longitude required.	2.44398

CASE 7.

To convert miles into minutes, or minutes into miles in any Latitude.

Queſt. 7. *Admit there be two places in the Latitude of* 46 deg. *diſtant* 750 *miles; I deſire to know the difference of Longitude between them.*

IT is to be conſidered, that a degree upon the greateſt Circle of the World (ſuch a one as divides the Globe of the Earth into two Hemiſpheres) is but 60 miles, as upon the Equinoctial, *&c.* Now though every ſmaller Circle or Parallel is 360 degrees about, yet thoſe degrees cannot be 60 miles in each; therefore we would know the meaſure of theſe ſmaller Circles in miles, or what number of degrees any number of miles will be in any of theſe leſſer Circles; which will be found by this

General

General Rule.

As the Complement of any Latitude, or the distance of that Parallel from the Pole,
Is in proportion to the Equinoctials distance from the Pole (or Radius);
So is the number of miles in that Parallel,
To the number of minutes contained in that number of miles.

Example, in the Case before us.

As *s. co.* 46 *deg.* 00′ of Latitude, *co. ar.*		0.15822
Is to *Radius* 90 *deg.*		
So is 750 miles in that Parallel,		2.87506
To 1079 minutes:		3.03328
	45	*d.* *m.*
Which converted into degrees and minutes, is 17 *deg.* 59′.	1079 (60	17 59
	60	

If you would turn minutes into miles, admit they were 1079′,

As *Radius*	
Is to *s. co.* the Latitude 46 *deg.* 00′;	9.84177
So is the number of minutes 1079,	3.03328
To the number of miles contained in those minutes 750 miles.	2.87505

Now from this Rule, a man may work his Reckoning daily at Sea. Imagine that the 10th day of *May*, *Munday*, 1684, I departed from the *Lizard*, which lieth in North Latitude 50 *deg.* 00′, and sailed West South West 102 miles;

Then South West by West	150 miles.
Then South West by South	100 miles.
Then South West	100 miles.
Then West South West	142 miles.
Then South West by West	100 miles.

And I would know daily the difference of Longitude that I have made, and keep my Reckoning by Longitude and Latitude, as indeed it was always my custom to do; and I have shewed this way by the Plain Scale. But this I always used:

I look in the Table for that purpose, which is in my Father's *Sea-*

mans Practice; and in this Book for the Meridian-diſtance that the firſt Courſe and diſtance makes, (or elſe I work it ſome other way) and I find

	Weſt.	*South.*
A Weſt South Weſt Courſe 102 miles, makes	94.0	40.0

This Southing I ſubſtract from the Latitude I ſet from, and it leaves the Latitude I am in 49 *deg.* 20′: (ſet it down in the Colume of Latitude); the Meridian-diſtance I ſet down in the Colume of Weſt Meridian-diſtance. And laſtly, for to find the Longitude that this Meridian-diſtance will make, I find the middle Latitude between yeſterday and this day; (I mean, that was between 50 *deg.* and what now I am in, when I have ſailed this 102 miles) as I have largely ſhewed. That done, I find it to be here 49 *deg.* 40′.

Then I ſay,

As *s. co.* the middle Latitude 49 *deg.* 40′	0.18893
Is in proportion to *Radius*;	
So is 94 miles,	1.97312
To 146 minutes, or 2 *deg.* 26′.	2.16105

And this makes up the firſt Line of the Reckoning to be expreſſed, as here underneath, thus: *The* 11th Tueſday *I was in the Latitude of* 49 deg. 20′, *and had Weſt Meridian-diſtance from the* Lizard 94 *miles*; *I had Weſt Longitude* 2 deg. 26′.

Secondly, for the next days Work.

	Weſt.	*South.*
South Weſt by Weſt 150 miles	124	84

I ſubſtract my Southing from the Latitude I was in yeſterday, and I have 47 *deg.* 56′ for my Latitude that I am in to day: Take then the Meridian-diſtance 124, and adde it to the Meridian-diſtance you had yeſterday, and ſo you have 218 for your whole Meridian-diſtance. Alſo take the middle Latitude between the Latitude yeſterday and to day, which is 48 *deg.* 38′, and ſay,

As *s. co.* 48 *deg.* 38′, *co. ar.*	0.17988
Is to *Radius*;	
So is the Meridian-diſtance 124 miles,	2.09342
To the difference of Longitude in minutes, 188′ or 3*d.* 8′	2.27330

Now

	deg.	min.
Now this difference of Longitude	3	08
Added to the Longitude before	2	26
Makes the whole Longitude to day	5	34

So that the ſecond Line is made up, and may be expreſſed thus: *The* 12th Wedneſday, *I was in the Latitude of* 47 deg. 56′; *I had Weſt Meridian-diſtance* 218 *miles*; *I had Weſt Longitude from the* Lizard 5 deg. 34′. And thus every day you may keep your Reckoning, as here following.

But for your fuller information in this matter, I refer you to what I have ſaid before concerning this matter; where I have treated fully of the manner of ſetting down your Reckoning daily. This is the Reckoning of the Courſes and Diſtances on the other ſide. I leave the practice of it to the Learner.

The 10th *of* May, Munday, *we departed from the* Lizard, Anno 1684; *it is in North Latitude* 50 deg. 00 min. *Here followeth my Weſting and Southing.*

Da. Mo.	Week-days.	Latitude. deg.	min.	Meridian-diſtance. miles.	Longitude W deg.	min.
11	*Tueſday*	49	20	094	02	26
12	*Wedneſday*	47	56	218	05	34
13	*Thurſday*	46	33	274	06	56
14	*Friday*	45	01	366	09	07
15	*Saturday*	44	08	498	12	10
16	*Sunday*	43	18	572	13	53

But to anſwer the Queſtion propounded, you may read daily your difference of Longitude in its Line for that day; for you ſee here it's ready caſt up.

For Example.

Admit it is the 10th day, I would know my Reckoning; I look upon that Line, and read it thus:

The 10th *of* May, Sunday, *I was in the Latitude of* 43 deg. 18′, *and was to the Weſtwards of the Meridian of the* Lizard 572 *miles*; *I had Weſt Longitude from it* 13 deg. 53′. And after the ſame manner you may read any other Line.

I uſe at Sea to work the proportion by *Gunter*'s Ruler for every day, becauſe that is ſoon done, and free from any miſtakes; but I leave every one to their own mind. I have been the briefer here, becauſe I have been very large on this way of keeping a Reckoning in this Treatiſe already.

Thus much for Mercator's *Sailing.*

About the Variation of the Compaſs.

I Had thoughts to have ſhewed at large, Rules for the Variation of the Compaſs; but I ſhall not inſiſt much upon it, becauſe 'tis treated of by ſo many already, and is ſo eaſie a thing, onely thus:

When by an *Azimuth Compaſs*, or the like, you obſerve the Sun at his Riſing or ſetting, and note the degree from the Eaſt or Weſt; ſo much as it differs from the true *Amplitude* (which you work for in the Sphere) ſo much is the Variation.

Example.

	deg.	*min.*
Admit the true Amplitude of the Suns Riſing were East Northerly	28	24
The Magnetical Amplitude, (or the Suns Riſing by the Compaſs) were East Northerly	20	00
Their difference, is the Variation	8	24

And it's Weſterly, becauſe the Eaſt point of the Compaſs is more Northerly than it ſhould be, or (which is more proper) the North point is more Weſterly than the true Meridian of North. I ſhall ſay no more of this here, but refer you to my Father's *Seamans Practice*, where it's largely treated of in page the 111 to page the 120; and alſo here in the Projection and Uſe of *Azimuth Compaſs.*

Here

Here followeth a Catalogue of the Longitude and Latitudes of the moſt principal Places in the World, beginning from the Meridian of the Lizard *of* England.

Latitude 50 deg. 00 min. *Longitude* 00 deg. 00 min.

Places in France, Spain, *and* Portugal; *their Names.*		Latitud. *deg.*	*min.*	Longit. *deg.*	*min.*	
Cape *de Hague*	N	50	04	02	28	E
Caskitts	N	50	06	01	53	E
Uſhant	N	48	38	00	00	E
Cape *de Machicaca*	N	44	20	01	39	E
Cape *Pinos*	N	44	03	01	27	W
Cape *Ortegal*	N	44	06	03	21	W
Cape *Finiſterre*	N	43	08	05	35	W
The Rock of *Lizbon*	N	38	58	05	54	W
Cape St. *Vincent*	N	37	00	07	18	W
Cape St. *Maria*	N	37	03	03	52	W
The *Streights Mouth*	N	36	00	01	57	W
Tangier	N	35	35	01	00	W

Head-lands and Places in the Streights; *their Names.*		Latitud. *deg.*	*min.*	Longit. *deg.*	*min.*	
Cape *de Gatte*	N	36	45	03	36	E
Cape St. *Martin*	N	38	43	06	18	E
Cape *Dega Frito*	N	41	39	09	10	E
Cape *Larci*	N	42	58	11	50	E
Cape *Melle*	N	43	56	13	42	E
Cape *Spartenentura*	N	37	46	23	29	E
Cape St. *Maria*	N	39	50	25	36	E
Anglo	N	41	30	23	50	E
Cape *Caſta*	N	43	23	22	18	E
Raguſa	N	42	30	24	56	E

Cape *Langa*	N	40	18	26	13	E
Cape *Metopan*	N	36	25	27	23	E
Cape St. *Angello*	N	37	12	30	19	E
Cape *Saradoni*	N	35	33	36	09	E
Cape *de Bacur*	N	32	38	48	11	E
Cape *Roſetta*	N	32	54	27	50	E
Cape *Bonna*	N	37	07	17	35	E
Tunis	N	36	43	07	09	E
Cape *Falcon*	N	36	05	04	48	E
Cape *Trees Forcas*	N	35	42	02	47	E

Iſlands in the Streights ; *their Names.*		Latitud. *deg. min.*		Longit. *deg. min.*		
Alboron	N	37	50	02	40	E
Formentera	N	38	42	07	00	E
Mayorca	N	39	40	08	40	E
Juica	N	39	08	07	13	E
Minorca	N	39	52	09	53	E
Gallatta	N	37	55	15	10	E
Cape *Pulo* in the Iſland of *Sardinia*	N	38	56	14	59	E
Cape *Corſica* in the Iſland of *Corſica*	N	42	50	14	58	E
Palmorolla	N	40	50	16	23	E
Lampadoſa	N	35	56	29	15	E
Malta	N	36	06	20	38	E
Cape *Paſſaro* in *Sicilia*	N	37	08	22	15	E
Marſina	N	38	07	22	21	E
Corfu	N	39	27	26	41	E
Cephalonia	N	38	25	27	52	E
Zant	N	37	37	28	03	E
The Weſt end of *Candia*	N	35	14	30	23	E
The Eaſt end of *Candia*	N	35	02	33	51	E
Rhodes	N	35	38	35	23	E
The Weſt end of *Cyprus*	N	34	20	38	54	E
The Eaſt end of the ſame	N	34	49	41	57	E

The Coaſt of Barbary *Southwards, and* Guiney ; *their Names.*		Latitud. *deg. min.*		Longit. *deg. min.*		
Cape *Sprat*	N	35	36	01	02	W
Cape *Cauteene*	N	32	22	01	02	W
Cape *Bajador*	N	26	50	10	13	W
Cape *Blanco*	N	20	32	13	41	W

Cape

Cape *Verde*	N	14	36	13	47	W
Sire Leone	N	08	00	09	05	W
Cape *de Palmos*	N	04	10	02	35	W

The Names of Places to the Cape.		Latitud. *deg. min.*		Longit. *deg. min.*		
Cape *Tres Puntas*	N	04	04	03	23	E
Cape *Formosa*	N	04	12	11	38	E
The North point of *Fernando Po*	N	03	28	14	46	E
Island *Principe*	N	01	48	15	43	E
Island *Cochas*	N	00	40	09	05	W
Island St. *Thoma*	N	00	10	14	53	E
Cape *Lopas*	S	01	00	15	03	E
Cape *Negro*	S	16	00	18	12	E
Cape *Sacos*	S	29	38	23	43	E
Cape *Bona Esperanza*	S	34	24	25	33	E

Islands scattering, as it were.		Latitud. *deg. min.*		Longit. *deg. min.*		
St. *Matthews* Island	S	01	43	01	05	W
The Island of *Anna Bonna*	S	01	22	13	23	E
Ascension Island	S	08	00	08	07	W
St. *Helena*	S	16	00	01	13	E
St. *Helena Nova*	S	16	02	12	11	E
Island *de Tristan*	S	36	56	00	05	E

The Main Continent in the East-Indies.		Latitud. *deg. min.*		Longit. *deg. min.*		
Cape *Lagulas*	S	35	00	00	53	E
Cape *Corentis*	S	23	30	43	23	E
Cape *de Guada*	S	15	17	47	19	E
Cape *de Guardafin*	N	11	40	61	38	E
Cape *Rasulgate*	N	22	05	71	33	E
Surrat	N	21	04	83	43	E
Goa	N	15	40	84	23	E
Cape *Comerin*	N	07	50	86	35	E
The South-west side of *Ceylen*	N	06	00	92	20	E
River *Bangalle*	N	22	09	97	43	E
Syam	N	14	52	110	08	E
Vischers Point	N	20	20	118	23	E
Point of *Cavallos*	N	25	16	128	21	E
Corea	N	36	06	133	23	E

Islands in the East-Indies.		Latitud. deg.	min.	Longit. deg	min.	
Island *Pracell*	N	10	23	80	44	E
Cubile	N	08	53	80	53	E
Moligue	N	09	03	81	48	E
Andaro	N	11	30	83	01	E
The North-west point of *Sumatra*	N	05	33	103	23	E
The North point of *Cellebes*	N	02	16	131	29	E
The middle of *Gelola*	N	00	00	124	43	E
Bachian	N	00	02	133	33	E
Machian	N	00	16	133	29	E
Motir	N	00	25	133	30	E
St. *Johannas*	N	04	12	126	13	E
South point of *Borneo*	S	04	18	122	58	E
North point of *Borneo*	N	07	41	121	58	E
West end of *Mandanno*	N	06	50	128	48	E
Anamba	N	02	38	114	05	E
St. *Juan*	N	08	14	133	43	E
Tendaia	N	12	00	132	28	E
Mandora	N	12	50	127	51	E
Perigoa	N	09	42	123	53	E
North end of *Lucon*	N	18	42	129	19	E
The middle of *Aynan*	N	19	00	118	23	E
South end of *Formosa*	N	21	20	129	28	E
North end of *Formosa*	N	28	10	130	39	E
Firando Island	N	33	00	144	38	E
West end of *Jappan*	N	34	00	137	28	E
North point of *Jappan*	N	40	05	150	43	E
Cape *Patience* in *Jesso*	N	39	00	173	23	E
South-east end of *Sumatra*	S	05	52	113	03	E
Bantum	S	06	15	113	59	E
Batavia	S	06	10	114	28	E
Tinior	S	09	52	133	16	E
Ceram	S	03	28	135	43	E
South end of *Celebes*	S	05	46	126	53	E
Romeyros	S	28	18	077	03	E
John de Lisbon	S	25	24	063	15	E
Diego Roize	S	20	05	072	28	E
St. *Brandon*	S	17	13	075	13	E
Dalgatius	S	15	20	069	38	E

St. *Appalonia*		20	50	61	23 E
South end of St. *Laurence*		25	39	55	23 E
North end of St. *Laurence*		11	03	60	23 E
Baſſoſe de India		22	08	48	03 E
John de Nova		17	22	50	38 E
Mayotta	S	12	41	53	53 E
Comore	S	11	19	52	33 E
De Natal	S	08	20	55	28 E
Coſmolede	S	09	40	59	31 E
John de Nova	S	09	00	67	09 E
De Alinranta	S	03	56	63	23 E
St. *Harmanos*	S	03	02	71	23 E
Diego Gritioſus	S	08	03	79	43 E
De Gamo	S	08	03	86	28 E
Adu	S	05	39	86	23 E
Appolonia	S	09	20	88	10 E

The Coaſt of Greenland.		Latitud. *deg. min.*		Longit. *deg. min.*		
Hercules Head-land	N	79	50	14	18	E
Fair Foreland, the North end	N	79	00	11	28	E
Black Point	N	78	32	12	33	E
Point-look-out	N	76	25	19	23	E
Cape *Blanco*	N	78	28	25	20	E
Hopeleſs Iſle	N	77	00	29	53	E

Other Iſlands in the North Sea.		Latitud. *deg. min.*		Longit. *deg. min.*		
Hope Iſland	N	76	13	29	13	E
Cherry Iſland	N	74	30	21	33	E
South point of *Trinity* Iſland	N	71	02	04	42	W
Gongus Foreland in *Trinity* Iſland	N	71	20	02	17	W

The Sea-coaſt of Nova Zembla, *and the White Sea.*		Latitud. *deg. min.*		Longit. *deg. min.*		
Orange Iſland	N	78	25	78	58	E
Ice Point	N	77	44	78	13	E
Langneſs	N	74	55	56	13	E
Fretum Burrough	N	72	25	62	23	E
Maurition's Iſland	N	71	24	59	30	E
Arch Angel	N	63	22	42	51	E

Swelgenoſe Switnoſs	N	69	10	49	01 E
Cape *Candenoſe*	N	69	35	56	58 E
Fox Noſe	N	64	10	24	30 E
Cape *Grace*	N	65	17	26	53 E
Cape *Galant*	N	67	10	26	55 E
Cape *Race*	N	65	49	27	27 E
North Cape	N	71	25	19	58 E
Roſe Iſlands	N	67	00	12	29 E
Cats Neſs	N	61	54	06	05 E
Naze of *Norway*	N	58	00	11	25 E

Gattigat *and the* Sound.		Latitud. *deg. min.*		Longit. *deg. min.*	
The *Noding*	N	57	00	13	03 E
Cape *Cole*	N	56	46	13	35 E
Falſterbome	N	56	50	13	48 E
Gotland	N	58	18	18	28 E
Burnt Holme	N	56	02	15	39 E

From the Schaw *to* Calice.		Latitud. *deg. min.*		Longit. *deg. min.*	
The *Schaw*	N	57	50	11	50 E
Bouenburg	N	56	20	11	19 E
Holy Land	N	54	28	09	39 E
The *Texel*	N	53	18	08	18 E
The *Brill*	N	52	08	07	07 E
Calice	N	51	13	05	28 E

Izland, *and near* Scotland.		Latitud. *deg. min.*		Longit. *deg. min.*	
Langneſs	N	67	20	08	52 W
Maze	N	68	26	21	27 W
Snow-hill	N	65	40	27	57 W
Merchants *Foreland*	N	63	36	13	57 W
Whales Back	N	65	18	09	35 W
St. *Kilda*	N	58	00	06	41 W
Skie Iſland	N	57	38	02	29 W
Lewis Iſle	N	58	30	04	37 W
Fair Izlands	N	61	43	03	37 W
Shotland	N	60	22	01	50 W

Scot-

Scotland, England, *and* Ireland.		Latitud. deg.	min.	Longit. deg.	min.	
Bradſey Iſle	N	52	46	10	58	W
Holly-head	N	54	42	00	53	W
Iſle of *Man*	N	54	25	00	50	W
Fair Foreland	N	55	35	02	21	W
Iſles of *Aron*	N	53	21	04	07	W
Sline-head	N	53	18	06	37	W
Black Rock	N	53	50	06	37	W
Blaſquits	N	52	16	07	14	W
Cape *Cleare*	N	51	16	06	09	W
Old head of *King-ſail*	N	51	41	05	06	W

The Weſtern Iſlands, and Canary *Iſles.*		Latitud. deg.	min.	Longit. deg.	min.	
Corva	N	40	00	27	07	W
The Weſt ſide of *Floores*	N	39	42	27	07	W
Fijal Road	N	38	50	24	59	W
The Weſt end of St. *George*	N	39	00	24	07	W
The Weſt end of *Tercera*	N	39	03	23	27	W
The Eaſt end of St. *Michaels*	N	38	00	20	50	W
The Eaſt end of St. *Maries*	N	37	00	21	00	W
Ferro to the Northwards	N	27	40	14	12	W
The Eaſt end of *Palma*	N	28	36	13	50	W
The Eaſt end of *Madera*	N	32	33	12	25	W
Pico Tentriſe	N	28	20	11	37	W
Porta Sangtoſe	N	33	00	11	35	W
The North-eaſt point of *Canaria*	N	28	15	09	47	W
The Iſland *Lancerota*	N	28	32	09	20	W
Forteventura, the North-eaſt ſide of it	N	28	24	09	45	W

The Cape de Verde *Iſlands.*		Latitud. deg.	min.	Longit. deg.	min.	
The Eaſt end of *Antonio*	N	18	00	22	37	W
Iſula Brava	N	14	40	21	29	W
Bonna Viſta	N	15	58	19	33	W
St. *Jago*	N	15	01	20	05	W
Isle of Sall	N	16	00	19	37	W

America *in the South Seas.*		Latitud. deg.	min.	Longit. deg.	min.	
The Streights of *Anian*	N	57	08	121	37	W

Cape *Blanco*	N	19	00	127	20	W
Sir *Francis Drake*'s Bay	N	38	16	126	07	W
Cape St. *Lucas*	N	23	08	106	18	W
Cape *de Paſſio*	N	00	00	081	02	W
Truckilla	S	04	32	089	37	W
Iſland *Ferando*	S	33	45	080	17	W
Port St. *Ciprion*	S	43	15	075	59	W
The Entrance of *Magallan Weſt*	S	53	00	075	25	W
Cape *Horn*	S	57	54	069	37	W
Prince *William*'s Iſland	S	18	12	155	10	W
States Land	S	38	00	190	37	W
Green Iſland	S	04	00	200	37	W
Hermones Iſle	N	15	12	191	32	W

The Main of America.

		Latitud. *deg. min.*		Longit. *deg. min.*		
The Streights of *La Mair*	S	55	00	062	11	W
The Eaſt Entrance of *Magilan*	S	52	20	067	37	W
Cape *Blanco*	S	47	30	062	52	W
Cape St. *Antonio*	S	36	36	047	37	W
Cape *Frio*	S	22	55	033	59	W
Cape St. *Maria*	S	35	00	034	20	W
Baia de Totas Sanctos	S	13	00	030	47	W
Cape St. *Auguſtine*	S	08	41	026	57	W
River *Caſipore*	N	04	06	044	32	W
Surinam	N	05	06	049	00	W
Cape *Rexo*	N	22	42	097	01	W
Cape *Florida*	N	25	30	096	21	W
Cape *Feare*	N	33	50	074	12	W
Cape *Henry*	N	37	00	071	57	W
Cape *Anne*	N	42	50	064	00	W
Cape *Codd*	N	42	20	063	57	W
Cape *Race*	N	46	36	043	07	W
Cape *Bonna Viſta*	N	49	19	044	01	W

Iſlands in the Weſt-Indies.

	Latitud. *deg. min.*		Longit. *deg. min.*		
Bermuda	32	20	58	00	W
Barbados	13	12	53	50	W
Deſeada	16	16	54	20	W
Antigua	16	36	54	30	W

Anguilla

Anguillo	18	38	55	30	W
Barbada	17	30	54	35	W
St. *Chriſtophers*	17	30	55	26	W
The Eaſt end of *Hiſpaniola*	18	46	64	27	W
The Weſt end of *Hiſpaniola*	18	27	72	27	W
Port Royal in *Jamaica*	18	18	75	27	W
Cape *Antonio* on *Cuba*	22	03	84	11	W
Great *Caimanis*	19	20	79	07	W
Tabago	11	12	55	37	W
Margarita	11	30	60	12	W
Tartugas	11	28	59	34	W
Bonire	12	32	64	02	W
Santa Villa	17	28	78	37	W
Gunabo	16	30	85	20	W
Cozumal	19	25	85	27	W

To the Northwards in Hudſon's Bay.		Latitud. *deg. min.*		Longit. *deg. min.*		
Cape *Camas*	N	53	40	045	45	W
Reſolution Iſland	N	61	00	051	00	W
The Kings *Foreland*	N	61	50	077	07	W
Queen *Anne*'s *Foreland*	N	63	53	078	57	W
Cape *Charles*	N	62	54	080	55	W
North end of *Mansfield* Iſland	N	62	43	087	58	W
Prince *Rupert*'s River	N	51	02	085	25	W
Cape *Monmouth*	N	54	42	089	37	W
Cape *Henneretta*	N	56	18	093	27	W
Port *Nelſon*	N	58	32	104	47	W
Cape *Southampton*	N	62	30	093	12	W
Sir *Dudly Diggs* Cape	N	75	06	074	37	W
Saunderſon's Town	N	68	00	058	29	W
Cape *Walſingham*	N	65	40	061	17	W
Cape *Comfort*	N	62	20	051	17	W
Cape *Deſolation*	N	61	22	047	32	W
Cape *Farewel*	N	69	45	030	58	W

CHAP. XXIX.

The Doctrine of Spherical Triangles.

Of the Affections *and* Nature *of* Spherical Triangles.

1. A *Spherical Triangle* is made of three Arches of three great Circles that interſect each other upon the ſurface of the *Sphere*; and their *Angles* are meaſured by the Arch of a *great Circle* deſcribed between the two ſides, whoſe Poles is the angular Point.

2. All *great Circles* of the *Sphere*, divides it into two equal parts or Hemiſpheres; and no ſide of a Triangle is ſo great as a Semi-circle.

3. The three ſides of a *Spherical Triangle* are leſs than 360 degrees. If two ſides of a Spherical Triangle be 180 degrees, the two Angles at the Baſe of that Triangle ſhall be 180 degrees; but if the ſides be leſs, the Angles will be alſo leſs.

4. A right angled Spherical Triangle, hath certainly one right Angle.

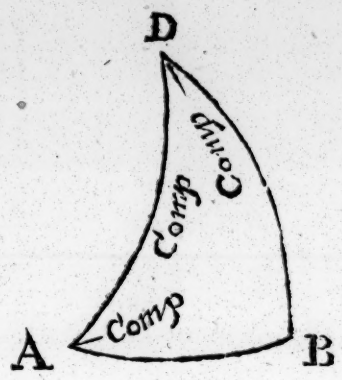
5. In a right angled Spherical Triangle, if either of the ſides next to the right Angle be a Quadrant, then is the Hypothinuſe a Quadrant alſo; but if their ſides be each leſs than a Quadrant, the Hypothinuſe will be ſo too; if one of them ſides ſhould be greater than a Quadrant, the Hypothinuſe will be ſo alſo.

6. An oblique Spherical Triangle hath either all the Angles acute (and then 'tis called an *acute angled Triangle*) or elſe *obtuſe*, or thirdly, *obtuſe* and *acute*, and then 'tis called an *obtuſe* angled Triangle.

7. If the Angles of a Triangle be all acute, the ſides of that Triangle are none of them ſo great as a Quadrant.

8. Every *Spherical Triangle* conſiſts of five parts, beſides the Right Angle; that is, the three ſides, and the two Angles. Now theſe parts are three of them noted to be *Complements*, and they be them that be fartheſt from the Right Angle; and the other two, which be next to the Right Angle, are not noted by their *Complements*, as you may ſee in the Triangle A B D right angled at B.

9. Now



9. Now if any two things begin in this Triangle, beſides the Right Angle, we may find the other things, as in right lined Triangle; but here muſt be ſeveral things conſidered.

10. For theſe ſides being Arches of Circles, are meaſured in degrees, as well as the Angles.

11. When you have found one of the Angles, the other is not its Complement to 90 degrees; but if you'll find the other, you muſt do it diſtinctly.

12. To work any Queſtion in either *right angled* or *oblique* Triangles, we may lay down this general *Axiome*.

General Axiome.

The Sine of the middle part with Radius, *is equal to the* Tangents *of the Adjacent Extremes, or to the Sines Complements of the Oppoſite Extremes.*

13. Within the bounds of this one *Axiome*, will all the *Caſes* of a *Spherical Triangle* (but two) fall; and them are the two laſt Caſes in Oblique Triangles.

14. So, that if a man underſtand but theſe three Lines well, he may frame all the Cannons, or work any thing that is to be done; and therefore it ſhall be my endeavour in every thing (as I go) to explain the Rule.

15. Pray mind one thing, and that is, That the Right Angle B is not counted to part the ſides next to it, whereas the other Angles do: So that we count BD and BA to joyn, whereas we count BA and AD as parted by the Angle between them A; and ſo is BD and DA by the Angle D. Theſe things premiſed, we come next to explain the *General Axiome*.

Admit in the Triangle ABD, I have given me BD, and the Angle at D, to find the ſide DA. I mind not yet which is *given*, nor what *required*; but onely that theſe be the three parts that we have to do with: Firſt then, I would know which of theſe is the *middle part*; and I believe you'll eaſily yield that D is, becauſe DB is one way next to it, and DA the other way.

Then I would know whether it be an *adjacent* or an *oppoſite extreme*.

And

And forasmuch as B D joyns to D, and D joyns to D A, (nothing being between them) I conclude it's an *Adjacent Extreme*, and the Angle at D (as we noted before) is the *middle part*.

I look upon the *General Axiome*, and that saith, That *the Sine of the middle part with Radius, is equal to the* Tangents *of the Adjacent Extremes*. I'll therefore call the *middle part* so, as that I may have the Sine of it, and the *two Extreams*, so as to have the Tangents of them; and they'll stand thus: *Sine Complement* D, with *Radius*, is equal to Tangent Complement D A, with Tangent D B, in short thus: *s. c.* D + *Radius* is = to *t. c.* D A + *t.* D B.

You may ask why I call the middle part *Sine Complement*, and the side D A *Tang. Comp.* when the Rule saith, *Sine* the middle part, and *Tangent* the exstreme; I answer, they be Complements already (and so they are noted in the Triangle); and if I would have the *s.* or the *t.* of them, I must call them *s. co.* or *t. co.* But the sides next the Right Angle, are not noted by their Complements, and therefore I call D B *t.* to find the Tangent of it.

The Question being brought to this, now mind what is *given*, and what is *required*, and set the things down in their order, onely taking care to set the thing required in the last place, (thus:)

t. D. B.
s. co. D
t. co. D A

Thus now if these things had been really given and required in a Triangle, you would have had the required thing by adding the Logarithms of the first two together, and looking for that sum, for it's the Logarithm of the third, casting away *Radius*, or the first figure on the left hand; as, if it were 19, to cast away the 1 from any Sine, and leaving onely the 9 before the Comma; or if a Tangent, cast away the first figure, if it exceed 12, before the Point or Comma.

But you may ask whether or no you should take the *Complement Arithmetical* of the first of the given things, as is usual to avoid substraction. For that, observe this *General Rule*.

> *That if the middle part and an Extreme be given, take the Complement Arithmetical of that Extreme; but if the two Extremes be given, to find the middle part, take no Complement Arithmetical at all.*

And under one of these two Notions all *Questions* will fall.

Secondly, (in the same Triangle) Admit the Angles at A and D were given, and the side D A were required; here D A is the middle part, and its an *Adjacent Extreme*: Therefore,

s. co.

s. co. D A + *Radius* is = to *t. co.* A + *t. co.* D } A *t. co.* / A D *s. co.* / D *t. co.* required.

Now here the *two Extremes* is given, to find the *middle part*; and therefore take no *co. ar.* at all.

Thirdly, Admit D A were given the Angle at A, and A B were required, it's an Adjacent Extreme, and A is the middle part.

s. co. A + *Radius* is = to *t. co.* A D + *t.* A B } *s. co.* A / *t. co.* A D *co. ar.* / *t.* A B required.

In this case the *middle part* and an *Extreme* is given, and therefore I take the Compl. Arith. of the given Extreme.

Fourthly, If A were given, and the side A B, and the side B D, were required; this is an Adjacent Extreme: for the Right Angle (as I have said before) doth not part the two sides; A B is the middle part.

s. A B + *Radius* is = to *t.* B D + *t. co.* A } A B *s.* / A *t. co. co. ar.* / D B required, *t.*

Fifthly, If A B and B D were given, and D were required; it's an *Adjacent Extreme*, and D B is the middle part.

s. D B + *Radius* is = to *t. co.* D + *t.* B A } *t.* A B *co. ar.* / *s.* B D / *t. co.* D

And these be the five *Adjacent Extremes*.

Of Opposite Extremes.

THat's an *Opposite Extreme* that hath one of the three things concerned lying alone; (but mind) I don't mean the Right Angle shall part any thing.

Imagine that in the Triangle A B D, I have given the side B D, the side D A, and that the Angle at A be required.

This now is an *Oppoſite Extreme*, and D B is the *middle part*, becauſe it lieth alone, and is equally parted from the other two things, namely D A by the Angle D, and A, by the ſide A B. I ſay then,

s. D B + *Radius* is = to *s.* D A + *s.* A } *s.* D A *co. ar.* / *s.* D B / *s.* A required.

Here you may ask why I call the ſide D A *Sine*, when the Rule ſaith, That *the Sine of the middle part with Radius, is = to the Sine Complement of the Oppoſite Extremes.* Now this is an Oppoſite Extreme (you'll ſay) and A D is one of the Extremes; why then is it called *Sine?*

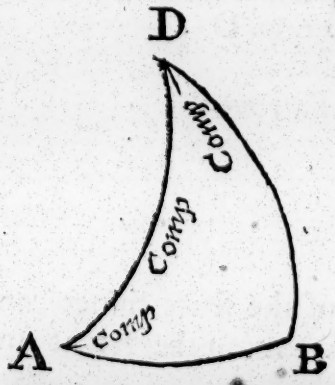
I anſwer, A D is noted a *Sine Complement*; and if I call him *Sine Complement*, I ſhall take the *Sine* of him, for he is a *Complement* already; (the *Complement* of a *Complement* is the *Sine* of that *Complement*) and therefore to have the *Sine Complement* of A D, I call it a *Sine.*

Secondly, Let the Angle at D and A be given, and let B A be required. Here D lies alone, and therefore is the *middle part*, and it's an *Oppoſite Extreme.*

s.co. D + *Radius* is = to *s.* A + *s.* A B } D *s. co.* / A *s. co. ar.* / A B *s.* required.

Here I call D *s. co.* to have the Sine of him (becauſe he is a Complement already) and the others Sine to have the *s. co.* of them, for the ſame reaſon.

Thirdly, Let D A and A B be given, and let D B be required. Here the ſide D A lieth alone (for we count the Right Angle doth not part any thing) and therefore it's an *Oppoſite Extreme*; and the ſide that lies alone, is the *middle part.*



s.co. A + *Radius* is = to *s.co.* A B + *s.co.* D B } D A *s. co.* / A B *s. co. co. ar.* / D B *s. co.* required.

Here I call D B *s. co.* to find the Sine of him, becauſe he is a Complement already; (I muſt find the Sine of him, becauſe he is the middle part) and the Rule ſaith, *the Sine of the middle part with Radius, is = to the Sine Complement*

ment of the Oppoſite Extremes. Then I call the other two *s. co.* to have their *s. co.* becauſe they be not noted Complements already, and they be *Extremes.*

Fourthly, Let A be given, B D be given, and let D be required. Here the Angle at A is alone, and therefore the middle part, and an *Oppoſite Extreme.* Then

s.co. A + *Radius* is = to *s.co.* B D + *s.* D } *s. co.* A, *s.* B D, *s.* D required.

Laſtly, Let A B and D be given, and let D A be required. In this caſe A B is alone, and ſo it's an *Oppoſite Extreme*, and A B the *middle part.*

s. A B + *Radius* is = to *s.* D + *s.* A D } *s.* D *co. ar.*, *s.* A B, *s.* D A required.

And thus you may frame a Rule to any Queſtion, in either Notion of *Adjacent* or *Oppoſite Extremes.* But I have found in teaching, the hardeſt thing hath been to make them underſtand when they ſhould call a thing a *s. s.c.t.* or *t.co.* but to free you from all miſtakes, obſerve this for a Rule.

Obſerve.

Call any of the five parts by their names, and you ſhall have the Sine or the Tangent of them; call them out of their names, and you ſhall have the Complement of them.

My meaning is thus:

The Angle A, the Angle D, and the ſide D A, are called *Complements:* call any of them *s. co.* or *t. co.* and you have the Sine or Tangent of them; call them Sine or Tangent, (which is out of their names) and you have the *s. co.* or *t. co.* of them.

In like manner, the ſides that lie next the Right Angle, are not noted by their Complements: therefore call them *s.* or *t.* and you have the Sine or Tangent of them (for that's their names); and by conſequence, call them *s. co.* or *t. co.* when you would have the Complements of them (that I call out of their names.)

Theſe Examples of the ten *Extremes*, are together thus:

Adjacent Extremes.

1. *Data.* { D B *t.* / D *s. co.* / D A requ. *t. co.* } *s. co.* D + *Rad.* is = to *t.* D B + *t. co.* D A

2. *Data.* { D *t. co.* / D A *s. co.* / A requ. *t. co.* } *s. co.* D A + *Rad.* is = to *t. co.* D + *t. co.* A

3. *Data.* { A D *t. co.* / A *s. co.* / A B requ. *t.* } *s. co.* A + *Rad.* is = to *t. co.* A D + *t.* A B

4. *Data.* { A *t. co.* / A B *s.* / B D requ. *t.* } *s.* A B + *Rad.* is = to *t. co.* A + *t.* B D

5. *Data.* { A B *t.* / B D *s.* / D required, *t. co.* } *s.* B D + *Rad.* is = to *t. co.* D + *t.* B A

Oppoſite Extremes.

1. *Data.* { B D *s.* / D A *s.* / A required *s.* } *s.* B D + *Radius* is = to *s.* D A + *s.* A

2. *Data.* { D *s. co.* / A *s.* / A B *s. co.* requ. } *s. co.* D + *Rad.* is = to *s.* A + *s. co.* A B

3. *Data.* { D A *s. co.* / A B *s. co.* / B D requ. *s. co.* } *s. co.* D A + *Rad.* is = to *s. co.* A B + *s. co.* D B

4. *Data.* { A *s. co.* / D B *s. co.* / D required, *s.* } *s. co.* A + *Rad.* is = to *s. co.* B D + *s.* D

5. *Data.* { A B *s. co.* / D *s. co.* / D A *s.* } *s.* A B + *Radius* is = to *s.* D + *s.* D A

After

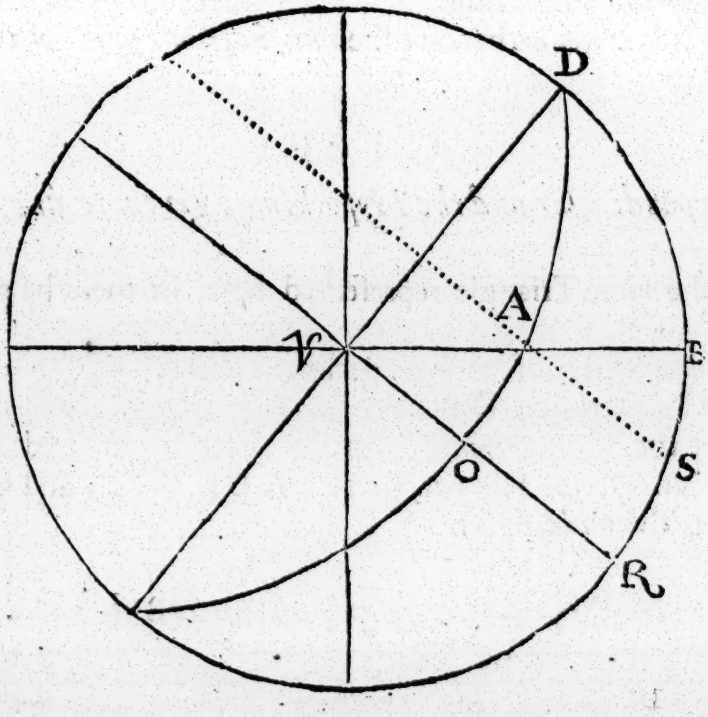
After this manner, you may frame a Rule for any thing, in such order, that you have need of no other consideration to work it, but to set the thing required in the third place, and to take the Complement Arithmetical of an Extreme, if it be given with the middle part, but else not.

These things premised, we are now fitted to work any thing in any Triangle, right angled or oblique, except it be when the three sides of an Oblique Triangle be given to find an Angle, or the three Angles given to find a side, which is the two last Cases of an *Oblique Triangle:* and therefore we will next handle the sixteen Cases of a right angled Spherical Triangle.

CASE 1.

Latitude Northerly 50 deg. 00 min. *Declination Northerly* 17 deg. 47 min. *I demand the hour of the Suns Rising.*

IN the Triangle A D B, the Poles Elevation is (in this following Scheme) D B; the Complement of the Suns declination is D A;



A D B is the Angle of the hour from midnight, whose measure is R O equal

equal to S A, the distance from midnight that the Sun traseth, to his rising; A B the Suns *Azimuth* of rising from the North, whose Complement to 90 *deg.* is A ♈, the Suns *Amplitude* of rising from the East; A is the Angle of the Suns Position.

In the Triangle A B D, then we have given,

	d.	*m.*
The Poles Elevation B D	50	00
The Complement of the Suns declination D A	72	13

And let the Angle at D be required, which is the hour from midnight to the Suns rising.

I consider it's an *Adjacent Extreme*, and that D is the *middle part.*

s. co. D + *Radius*, is = to *t.* D B + *t. co.* D A.

D B *t.* 50 *deg.* 00′	10.0761865
D A *t. co.* 72 *deg.* 13′	9.5061586
A D B *s. co.* 67 *deg.* 32′	9.5823451

That is (converted into time) 4 *ho.* 30′ $\frac{2}{15}$: so long after midnight it is to the Suns rising.

Here I took no *co. ar.* because the two *Extremes* was given to find the *middle part.*

CASE 2.

The Perpendicular and the Hypothinuse given, to find the Base.

In the same Triangle represented here, let there be given,

	d.	*m.*
The Complement of the Suns declination D A	72	13
The Poles Elevation D B	50	00

And let the Suns *Azimuth* from the North be required B A.

This is an *Opposite Extreme*, because A D is alone; and for the same reason it is the *middle part*,

s. co. A D + *Radius*, is = to *s. co.* D B + *s. co.* A B.

s. co. D B 50 *deg.* 00′, *co. ar.*	0.191932
s. co. D A 72 *deg.* 13′	9.484895
s. co. A B 61 *deg.* 38′	9.676827

Thus

Thus the Sun riſeth North 61 *deg.* 38′ Eaſterly, or Eaſt 28 *deg.* 24′ Northerly, which is his *Amplitude.*

I took the *co. ar.* of the given *Extreme*, becauſe 'twas with the *middle part.*

CASE 3.

The Perpendicular and the Hypothinuſe given, to find the Angle at the Baſe.

Let there be given as before,

A D 72 *deg.* 13′
B D 50 *deg.* 00′ } And let the Angle of Poſition be required.

This is an *Oppoſite Extreme*, and D B lieth alone, and is the *middle part.* Say,

s. D B + *Radius*, is = to *s.* D A + *s.* A.

s. D A 72 *deg.* 13′, *co. ar.*	0.021263
s. D B 50 *deg.* 00′	9.884254
s. A 53 *deg.* 34′	9.905517

The *middle part* and an *Extreme* is given here, and therefore I take the *co. ar.* of the *Extreme.*

CASE 4.

The Perpendicular, and the Angle at the Perpendicular given, to find the Hypothinuſe.

Admit in the Triangle A D B there be given,

	d.	*m.*
The Perpendicular B D	50	00
The Angle at the Perpendicular D	67	32

And let it be required to find D A.

This is an *Adjacent Extreme*, and D is the *middle part.*

s. co. D + *Radius*, is = to *t. co.* D A + *t.* D B.

D B

DB *t.* 50 *deg.* 00′, *co. ar.*	9.92381
D *s. co.* 67 *deg.* 32′	9.58222
DA *t. co.* 72 *deg.* 13′	9.50603

Here the *Compl. Arith.* of the given *Extreme* is taken, becauſe it's given with the *middle part.*

CASE 5.

The Perpendicular, and the Angle at the Perpendicular given, to find the Angle at the Baſe.

Let there be given in the Triangle ABD,

The Angle at D 67 *deg.* 32′
The Perpendicular DB 50 *deg.* 00′ } And let the Angle at A be required.

Here A is alone, and therefore it's an *Oppoſite Extreme*, and A is the *middle part.*

s. co. A + *Radius*, is = to *s. co.* DB + *s.* D.

DB *s. co.* 50 *deg.* 00′	9.80806	Here we took no *Complement Arith.* becauſe the two *Extremes* be given to find the *middle part.*
D *s.* 67 *deg.* 32′	9.96571	
A *s. co.* 53 *deg.* 34′	9.77377	

I ſhall note no farther about the *middle part*, and the *Complement Arithmetical*; but bid you mind the Rule.

CASE 6.

The Perpendicular, and the Angle at the Perpendicular given, to find the Baſe.

Let there be given,

	d.	*m.*	
BD	50	00	*s.* BD + *Radius*, is = to *t.* BA + *t. co.* D.
D	67	32	

And let the *Baſe* BA be required.

D *t. co.*

D *t. co.* 67 *deg.* 32′, *co. ar.*	0.38349
DB *s.* 50 *deg.* 00′	9.88425
BA *t.* 61 *deg.* 38′	10.26775

CASE 7.

The Perpendicular, and the Angle at the Base given, to find the Angle at the Perpendicular.

Let there be given,

	d.	*m.*	
DB	50	00	*s. co.* A + *Radius*, is = to *s. co.* DB + *s.* D.
A	53	34	

And let the *Angle* at D be requir.

DB *s. co. co. ar.* 50 *deg.* 00′	0.19193
A *s. co.* 53 *deg.* 34′	9.77370
D *s.* 67 *deg.* 32′	9.96563

CASE 8.

The Perpendicular, and the Angle at the Base given, to find the Hypotenuse.

Let there be given,

	d.	*m.*	
DB	50	00	*s.* DB + *Radius*, is = to *s.* DA + *s.* A.
A	53	34	

And let A D be required.

s. A 33 *deg.* 34′, *co. ar.*	0.09435
s. BD 50 *deg.* 00′	9.88425
s. DA 72 *deg.* 30′	9.97860

CASE 9.

The Perpendicular and the Angle at the Base *given, to find the* Base.

Let there be given,

	d.	*m.*	
D B	50	00	*s.* B A + *Radius*, is = to *t.* B D
A	53	34	+ *t. co.* A.

And let A B be required.

B D *t.* 50 *deg.* 00′	10.07618
A *t. co.* 53 *deg.* 34′	9.86815
A B *s.* 61 *deg.* 38′	9.94433

CASE 10.

The Base *and the Perpendicular given, to find the Angle at the Perpendicular.*

Let there be given,

	d.	*m.*	
D B	50	00	*s.* D B + *Radius*, is = to *t. co.* D
A B	61	38	+ *t.* B A.

And let D be required.

B A *t.* 61 *deg.* 38′, *co. ar.*	9.73235
B D *s.* 50 *deg.* 00′	9.88425
D *t. co.* 67 *deg.* 32′	9.61660

CASE 11.

The Base *and Perpendicular given, to find the Hypotenuse.*

Let there be given in the Triangle A B D,

	d.	*m.*	
The *Base* B A	61	38	*s. co.* D A + *Radius*, is = to *s. co.*
The *Perpendicular* B D	50	00	B A + *s. co.* B D.

And let D A the *Hypot.* be requir.

A B

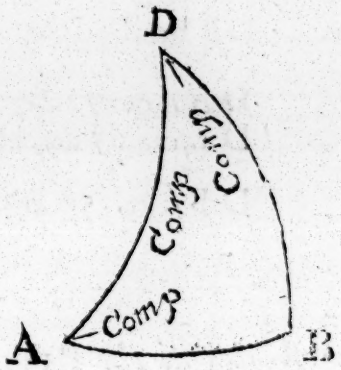
AB *s. co.* 61 *deg.* 38′	9.67679
BD *s. co.* 50 *deg.* 00′	9.80806
DA *s. co.* 72 *deg.* 13′	9.48485

CASE 12.

The Angle at the Perpendicular, and the Hypotenuſe given, to find the Angle at the Baſe.

Let there be given in the Triangle A B D,

	d.	*m.*	
D	67	32	*s. co.* AD + *Radius*, is
DA	72	13	= to *t. co.* D + *t. co.*
And let A be required.			A.



D *t. co.* 67 *deg.* 32′, *co. ar.*	0.38349
DA *s. co.* 72 *deg.* 13′	9.48489
A *t. co.* 53 *deg.* 34′	9.86838

CASE 13.

The Angle at the Perpendicular, and the Hypotenuſe given, to find the Baſe.

Let there be given,

	d.	*m.*	
D	67	32	*s.* AB + *Radius*, is = to *s.* DA
DA	72	13	+ *s.* D.
And let A B be required.			

D *s.* 67 *deg.* 32′	9.96571
DA *s.* 72 *deg.* 13′	9.97873
AB *s.* 61 *deg.* 38′	9.94444

CASE 14.

The Angle at the Perpendicular, and the Hypotenuse given, to find the Perpendicular.

Let there be given,

	d.	m.	
The *Angle* at D	67	32	*s. co.* D + *Radius*, is = to *t. co.*
The *Hypotenuse* D A	72	13	DA + *t.* DB.

And let D B be required.

D A *t. co.* 72 *deg.* 13′, *co. ar.*	0.49384
D *s. co.* 67 *deg.* 32′	9.58222
D B *t. co.* 50 *deg.* 00′	10.07606

CASE 15.

The Angles at the Base, *and Perpendicular given, to find the Hypotenuse.*

In the Triangle A D B, Let there be given,

	d.	m.	
D	67	32	*s. co.* A D + *Radius*, is = to *t. co.*
A	53	34	A + *t. co.* D.

And let A D be required.

t. co. D 67 *deg.* 32′	9.617224
t. co. A 53 *deg.* 34′	9.868151
s. co. D A 72 *deg.* 13′	9.485375

CASE 16.

The Angles given, to find the Perpendicular.

	d.	m.	
Let A be	67	32	*s. co.* A + *Radius*, is = to *s. co.*
And D be	53	34	DB + *s.* D.

And let D B be required.

s. co.

s. co. A 53 *deg.* 34′	9.77370
s. D 67 *deg.* 32′, *co. ar.*	0.03428
s. co. D B 50 *deg.* 00′	9.80798

And these be the sixteen Cases of a *right angled Spherical Triangle*: They might be varied several ways, but this is sufficient to resolve any thing that shall be put; for it must come under one of these Cases. I come now to apply these Cases to the solution of several *Problems* in *Astronomy*.

But before I proceed to their application in *Astronomical Problems*, I will give you a brief *Synopsis* of all the *Canons* (throughout all the sixteen *Cases* of *Right angled Spherical Triangles*) deduced from the *Fundamental AXIOME*: The *Canon*, *Analogie*, or *Proportion*, being laid down (for every *Case*) in words at length.

I. *The* Base, *and* Angle at the Base given; *to find the*

1. *Perpendicular.* As *Radius*, to the Sine of the *Base*; So the Tang. of the *Angle* at the *Base*, to the Tang. of the *Perpendicular*.

2. *Angle* at the *Perpendicular.* As *Radius*, to Sine Comp. the *Base*; So Sine *Angle* at the *Base*, to Comp. Sine *Angle* at the *Perpendicular*.

3. *Hypotenuse.* As *Radius*, to Comp. Sine *Angle* at the *Base*; So Comp. Tang. *Base*, to Comp. Tang. *Hypotenuse*.

II. *The* Perpendicular, *and* Angle *at the* Base *given*; *to find the*

1. *Angle* at the *Perpendicular.* As Comp. Sine *Perpendicular*, to *Radius*; So Comp. Sine *Angle at Base*, to Sine *Angle* at the *Perpendicular*.

2. *Hypotenuse.* As Sine *Angle* at the *Base*, to *Radius*; So Sine *Perpendicular*, to Sine *Hypotenuse*.

3. *Base.* As *Radius*, to Comp. Tang. *Angle at Base*; So Tang. *Perpendicular*, to Sine of the *Base*.

III. *The* Hypotenuſe, *and* Angle *at the* Baſe *given*; *to find the*

1. *Baſe.* { As *Radius*, to Comp. Sine *Angle* at the *Baſe*; So Tang. *Hypotenuſe*, to Tangent the *Baſe*.

2. *Perpendicular.* { As *Radius*, to Sine *Hypotenuſe*; So Sine *Angle at Baſe*, to Sine *Perpendicular*.

3. *Angle* at the *Perpendicular.* { As *Radius*, to Comp. Sine *Hypotenuſal*, So is Tang. *Angle* at the *Baſe*, to Comp. Tang. *Angle at the Perpendicular*.

IV. *The* Baſe, *and* Perpendicular *given*; *to find the*

1. *Hypotenuſe.* { As *Radius*, to Comp. Sine *Perpendicular*; So Comp. Sine *Baſe*, to Comp. Sine *Hypotenuſe*.

2. *Angle* at *Baſe.* { As *Radius*, to Sine of the *Baſe*; So Comp. Tang. *Perpendicular*, to Comp. Tang. *Angle* at *Baſe*.

V. *The* Baſe, *and* Hypotenuſe *given, to find the*

1. *Perpendicular.* { As Comp. Sine *Baſe*, to *Radius*; So Comp. Sine *Hypotenuſe*, to Comp. Sine *Perpendicular*.

2. *Angle* at the *Baſe.* { As *Radius*, to Tang. the *Baſe*; So Comp. Tang. *Hypotenuſe*, to Comp. Sine *Angle* at *Baſe*.

3. *Angle* at Perdicular. { As Sine *Hypotenuſe*, to *Radius*; So Sine of the *Baſe*, Sine *Angle* at the *Perpendicular*.

VI. *The* Angles *at the* Baſe, *and* Perpendicular *given, to find the*

1. *Perpendicular.* { As Sine *Angle* at the *Perpendicular*, to *Radius*; So Comp. Sine *Angle* at the *Baſe*, to Comp. Sine *Perpendicular*.

2. *Hypotenuſe.* { As *Radius*, to Co. Tan. of *Angle* at the *Perpendicular*; So Comp. Tang. the *Angle* at the *Baſe*, to Sine Comp. the *Hypotenuſal*.

CHAP. XXX.

The Application of Right Angled Spherical Triangles, to ſome Queſtions or Problems in Aſtronomy.

PROB. I.

Latitude 50 deg. 00 min. *Northerly, Declination Northerly* 17 deg. 47 min. *I demand the Suns Amplitude of Riſing or Setting, and the difference of Aſcenſion.*

Fig. I. IN the Scheme R B *b.* S, repreſents the Parallel of the *Suns Declination*; B, the place of the *Suns Riſing*; B *b*, is the *difference of Aſcenſion*, equal to ♉. So that in the Triangle ♉ A B (right angled at A) we have given the *Angle* at ♉, the Complement of the Latitude 40 *deg.* 00′; (it is meaſured by the *Arch* D K.) The ſide A B the *Suns Declination*, to find the *difference of Aſcenſion* A ♉ and B ♉. Firſt, for the *difference of Aſcenſion.*

This is an *Adjacent Extreme*, and A ♉ is the middle part.

s. A ♉ + *Radius*, is = to *t.* A B + *t. co.* ♉.

t. A B 17 *deg.* 47′	9.50615
t. co. ♉ 40 *deg.* 00′	10.07618
s. A ♉ 22 *deg.* 28′	9.58233

Which converted into time, is 1 *ho.* 29′ 52″; ſo much the Sun riſeth before ſix of the Clock. By the knowing of which, ſeveral things will be found; as, the time of the *Suns Riſing and Setting*, the *Length of the Day and Night*: For if I ſubſtract the *difference of Aſcenſion* from 6 of the Clock, it gives me the time of the *Suns Riſing*; if I adde it to 6 *ho.* it gives me the time of the *Suns Setting* (or the length of the afternoon;) which doubled, is the *Length of the Day*; and that ſubſtracted from 24 hours, gives me the *Length of the Night.*

PROB.

PROB. II.

For the Suns Amplitude *of* Rising *or* Setting, *we have given*

A B the *Suns Declination*, 17 *deg.* 47′
A ♈ B the Comp. of the Latit. 40 *deg.* 00′
To find ♈ B the *Suns Amplitude* of Rising.

} *s.* B A + *Radius*, is = to *s.* ♈ + *s.* ♈ B.

s. B A 17 *deg.* 47′	9.48489
s. ♈ 40 *deg.* 00′, *co ar.*	0.19193
s. ♈ B 28 *deg.* 24′	9.67682

Thus the Sun riseth East 28 *deg.* 24′ Northerly; you may see it's Northerly, by the Scheme.

And the *Amplitude* of the Suns Rising, is very useful at Sea, to find the *Variation of the Compass:* for so much as the Sun riseth by the Compass to the Northwards, or Eastwards of this true *Amplitude* of the Sun, so much is the Variation of the Compass; and you must rectifie your Course accordingly.

Now this little Triangle, (if you mind it) is made of the Complements of that Triangle B D E, which I wrought the Cases by; and if you substract the things found in this, from those *Arches* to 90 *deg.* you'll find the remainder S to be the sides of that; as in the Scheme, E D is the Poles Elevation, D K is the measure of the *Angle* at ♈, and is the Complement of the Poles Elevation.

B E D is the hour from midnight to the Suns rising, K A is the measure of that *Angle*, whose Complement to 90 *deg.* is A ♈, the difference of *Ascension*, or the time between six of the Clock and the Suns rising.

D B is the Suns *Azimuth* from the North, B ♈ is the Suns *Amplitude* of rising, and the Complement of that; the *Angles* at B in each Triangle are equal; E B is the Complement of the *Suns Declination*; B A is the Complement of that (namely, the *Suns Declination.*)

I made use of the *Angle* B E D to lay down the Cases, because it's more visible, and so sheweth more plainly than any other Triangle in the Sphere. I suppose my Father made use of that Triangle for that reason, and for the sake of the other *Angles* that depend upon it.

PROB.

PROB. III.

Latitude 50 deg. 00 min. *Northerly, Declination Northerly* 17 deg. 47 min. *I demand the Suns height at 6 a Clock.*

Z 6 O is an *Azimuth* intersecting the Horizon, and cutting the Parallel of Declination, in the place where the Sun is at six of the Clock; so that O 6 is the Suns height at six a Clock: and to find it, we have in the little Triangle 6 ♉ O the *Angle* at the center ♉, the Poles Elevation. It's measured by the *Arch* E D 50 *deg.* 00′

The *Suns Declination* ♉ 6 17 *deg.* 47′

It's an *Opposite Extreme*, and O 6 is the *middle part.*

s. 6 ♉ O + *Radius*, is = to *s.* ♉ 6 + 6 O.

s. ♉ 6 17 *deg.* 47′	9.48489
s. 6 ♉ O 50 *deg.* 00′	9.88425
s. 6 O 13 *deg.* 32′	9.36914

Let the Latitude be the *Angle* O ♉ 6 50 *deg.* 00′

The *Suns Declination* be ♉ 6 17 *deg.* 47′

And let the Suns *Azimuth* be required O ♉ = to 6 *l*

s. co. ♉ O + *Radius*, is = to *t. co.* ♉ 6 + *t. co.* 6 O.

t. co. ♉ 6 17 *deg.* 47′, *co. ar.*	9.50615
s. co. 6 ♉ O 50 *deg.* 00′	9.88425
t. ♉ O 14 *deg.* 13′	9.39040

PROB. IV.

Latitude Northerly 50 deg. 00 min. *Declination Northerly* 17 deg. 47 min. *I demand the Suns height, being due East or West.*

LEt E X C be a Meridian, cutting the East and West *Azimuth* in the place where the Sun is when he is over the East point of the Compass (which is at X.) Then in the little Triangle X C ♉ (right angled at C) you have the Latitude given X ♉ C 50 *deg.* 00′ (measured by the *Arch* Z P the Latitude, or Equinoctials distance from

the *Zenith*) and X C the *Suns Declination* to find X ♉, the Suns height being over the East point of the Horizon.

s. C X + *Radius*, is = to *s.* X ♉ + *s.* X *b* C.

s. X ♉ C 50 *deg.* 00′, *co. ar.*	0.11574
s. X C 17 *deg.* 47′	9.48489
s. X ♉ 23 *deg.* 30′	9.60063

Prob. V.

Latitude 50 deg. 00 min. *Northerly*, *Declination Northerly* 17 deg. 47 min. *I demand the time of the Suns being due East.*

IN the Triangle X C ♉ let C ♉ X be the Latitude 50 *deg.* 00′ And let C X be the *Suns Declination* 17 *deg.* 40′ required C ♉ = to 6 X.

s. ♉ C + *Radius*, is = to *t. co.* ♉ + *t.* X C.

t. C X 17 *deg.* 47′	9.50615
t. X ♉ C 50 *deg.* 00′	10.07618
s. ♉ C 22 *deg.* 28′	9.58233

And this 22 *deg.* 28′ converted into time, is 1 *ho.* 29′ 52″; which (in this Case) added to six hours, gives the time of the Suns being due East, namely 7 *ho.* 29′ 52″.

Prob. VI.

Latitude 50 deg. 00 min. *Northerly*, *Declination Northerly* 17 deg. 47 min. *I demand the Suns place in the Ecliptick, allowing his greatest Declination to be* 23 deg. 30 min. April *the* 30th 1690.

IN this Case we have no need of knowing the Latitude, for the finding the Suns place; but in the Triangle ♉ *b a* (right angled at *a*) we have given,

b ♉ *a* the Suns greatest Declination	23 *deg.* 30′
a b is the present Declination	17 *deg.* 47′

And ♉ *b* is required (the Suns place in the Ecliptick.)

s. b a

s. b a + *Radius*, is = to *s. b* + *s. b a.*

s. b a 17 *deg.* 47′	9.48489
s. a ♉ *b* 23 *deg.* 30′, *co. ar.*	0.39930
s. a ♉ 49 *deg.* 59′	9.88419

Now this 49 *deg.* 59′ divide by 30 *deg.* and it gives me the degree of the Sine the Sun is in, because 30 degrees is one Sine.

I find it comes to 19 *deg.* 59′ above one Sine; so that he must be in 19 *deg.* 59′ of ♉.

PROB. VII.

The Suns greatest Declination is 23 deg. 30 min. *and let the Suns present Declination be* 17 deg. 47 min. *I demand his right Ascension,* April *the* 30th 1690.

In the Triangle ♉ *b a* we have given,

b a 17 *deg.* 47′
b ♉ *a* 23 *deg.* 30′
And ♉ *a* is required.

} *s. a* ♉ + *Radius*, is = to *t. co.* ♉ + *t. b a.*

t. b a 17 *deg.* 47′	9.63830
t. co. ♉ 23 *deg.* 30′	19.50615
s. a ♉ 47 *deg.* 28′	9.86785

PROB. VIII.

Let the greatest Declination be (*as before*) 23 deg. 30 min. *and the Suns place in the Ecliptick be* 49 deg. 59 min. *I demand his present Declination.*

In the same Triangle ♉ *b a* is given,

♉ *b* 49 *deg.* 59′
a ♉ *b* 23 *deg.* 30′
required *b a* the present Declination.

} *s. a b* + *Radius*, is = to *s. b* ♉ + *s.* ♉.

s. ♉ *b* 49 *deg.* 59′	9.88414
s. a ♉ *b* 23 *deg.* 30′	9.60069
s. ab 17 *deg.* 40′	9.48483

PROB. IX.

Latitude Northerly 50 deg. 00 min. *Declination Northerly* 17 deg. 47 min. *I demand the continuance of Twi-light.*

IT's the Opinion of all men, that when the Sun is 18 degrees under the Horizon, the day breaks. Admit it so here; and let L 18 be a Parallel 18 degrees below the Horizon; Z *e* is a great Circle or Azimuth intersecting the Parallel of 18 degrees in the point *e*: So that in the right angled Triangle ♉ *e n* (right angled at *n*) we have given,

e n 18 *deg.* 00′
e ♉ *n* 40 *deg.* 00′ } *s. e n* + *Radius*, is = to *s. e* ♉ *n* + *s.* ♉ *a*.
to find *e* ♉

e n s. 17 *deg.* 00′	9.48998
e ♉ *n s.* 40 *deg.* 00′, *co. ar.*	0.19193
♉ *a s.* 28 *deg.* 45′	9.68191

And this 26 *deg.* 59′ converted into time, is 1 *ho.* 48′ nearest the continuance of Twi-light.

Note, That Q B is the continuance of Twi-light, but it is equal to ♉ *a*, here found.

PROB. X.

To find the time of Day breaking.

WE'll give the same Latitude and Declination as before, and find by it the continuance of Twi-light (as we have done before) to be 1 *ho.* 48′; this substracted from the time of the Suns rising, which was found before to be 4 *ho.* 30′ 08″, leaves the time of day breaking 2 *ho.* 42′ $\frac{2}{11}$; or if you adde it to the time of the Suns setting, it gives the time of Twi-light ending 09 *ho.* 17′.

PROB.

PROB. XI.

To find the length of the Longest day in any Latitude.

Latitude 50 deg. 00 min. *Northerly, Declination Northerly* 23 deg. 30 min. *I demand the length of the Longest day in that Latitude.*

Fig. II. I Consider that the Longest day in the year in any North Latitude, is when the Sun is in the *Tropick of Cancer*; and that's the reason that I give the greatest Declination Northerly, which is upon the 10th of *June*: so then in the Scheme Fig. II. P A B is a Meridian, cutting the Horizon in that place where the Sun riseth, namely at A; and in the Triangle A B ♈ (right angled at B) we have given,

A B the Suns greatest Declination 23 *deg.* 30′
B ♈ A the Complement of the Latitude 40 *deg.* 00′
To find B ♈ (= to A *b*) the difference of Ascension that day.

s. B R + *Radius*, is = to *t.* B A + *t. co.* B ♈ A,

t. B A 23 *deg.* 30′	9.63830
t. co. B ♈ A 40 *deg.* 00′	0.07618
s. B ♈ 31 *deg.* 13′	9.71448

This 31 *deg.* 13′ converted into time, is 2 *ho.* and near 5′; which added to 6 hours, gives the length of the Forenoon

	ho.	*min.*
B O = to A L	08	05
Which doubled, makes the length of the day	16	10

PROB. XII.

To find the length of the Shortest Night.

FInd the length of the longest day, as before, and substract that from 24 hours, and it gives the shortest Night. It's here 7 *ho.* 50′

PROB.

PROB. XIII.

Latitude 50 deg. 00 min. *Northerly, Declination Northerly* 17 deg. 47 min. *I demand the length of the shortest day in that Latitude.*

I Know the length of the shortest day is = to the length of the shortest night, and that was done in the last *Problem*; but admit it was not found, In the Scheme P F D is a Meridian, cutting the Sun at his rising when he is in the *Tropick of Capricorn* (namely at D) and in the Triangle D F ♑ (right angled at Æ) you have given,

D ♑ Æ, the Complement of the Latitude (whose measure is O K) 40 *deg.* 00′

F D the Suns Declination Southerly 23 *deg.* 30′

And ♑ F (which is = to 6 D) is required, the difference of Ascension that day.

s. ♑ Æ + *Radius*, is = to *t. co.* D ♑ F + *t.* F D.

t. Æ D 23 *deg.* 30′	9.63830
t. co. D ♑ Æ 40 *deg.* 00′	0.07618
s. ♑ Æ 31 *deg.* 13′	9.71448

This converted into time, and substracted from 6 hours, gives the length of the Forenoon; which doubled, is the length of the shortest day in that Latitude.

Example.

Æ O is = to D *b*, the length of the Forenoon. Now you may see that is not 6 hours by F ♑; therefore substract Æ ♑ from it,	6 *ho.* 00′ 2 *ho.* 05′	
And it leaves the length of the Forenoon;		3 55
		2
Which doubled, is the length of the day.		7 50

PROB.

PROB. XIV.

Latitude Northerly 50 deg. 00 min. *Declination Southerly* 17 deg. 47 min. *I demand the Suns Amplitude of Rising.*

Fig. III. IN the Scheme Fig. III. in the Triangle C R ♑, right angled at R, we have given,

The Suns Declination C R 17 *deg.* 47′
The Complement of Latitude C ♑ R 40 *deg.* 00′
And the Amplitude of the Suns Rising ♑ C is required.

} *s.* R C + *R ad.* is = to *s.* C ♑ + 8 ♑.

I leave the operation of it to your own practice.

PROB. XV.

Latitude Northerly 50 deg. 00 min. *Declination Southerly* 17 deg. 47 min. *I demand the difference of Ascension.*

IN the same Triangle C R ♑, we have given R C the Suns Declination, and R ♑ C the Complement of the Poles Elevation, to find ♑ R = to C 6, the difference of Ascension. If it were wrought, it would be 22 *deg.* 28′, or 1 *ho.* 30′ (nearest) and so much the Sun riseth after 6 of the Clock.

Therefore that substracted from 6 hours, leaves the length of the Forenoon R M = to G B; which doubled, is the length of the day;

That substracted from 24 hours, is the length of the night.

The difference of Ascension (in this case) added to 6 hours, gives the time of the Suns rising, because 'tis after 6 of the Clock.

The same difference of Ascension substracted from 6 hours, gives the time of the Suns setting.

The Suns Azimuth at 6 of the Clock is 6 *b* = to 4 ♑, and in the Triangle 4 ♑ 6, right angled at 4, we have given 6 ♑ 4 the Latitude, and ♑ 6 the Declination, to find 4 ♑; I leave the operation of it to your own practice.

PROB.

PROB. XVI.

Latitude 50 degrees *Northerly*, *Declination Southerly* 17 deg. 47 min. *I demand the Suns place and Right Ascension*, November, 1684.

THe Suns place in the Ecliptick is in the Southern Signes, because his Declination is Southerly, it is ☉ ♎; and in the Triangle ♎ W ☉, right angled at W, you have the Suns greatest Declination given, ☉ ♎ W 23 *deg.* 30′, and his present Declination ☉ W 17 *deg.* 47′, whereby you find the Right Ascension in the Southern Signes, as before you did the same things in the Northern Signes.

The Suns Right Ascension is W ♎, in the same Triangle, and is found with the same given things that his place is.

PROB. XVII.

Latitude 50 degrees *Northerly*, *Declination Southerly* 17 deg. 47 min. *I demand the time of the Suns being due East.*

IN this case the Sun is under the Horizon, when he passeth the East point of it, as at *t*: so that *t* 6 is found in the Triangle ♎ X *t*, it being = to X ♎; and we have *t* X, and *t* ♎ X given, to find it: When it is found, substract it from 6 of the Clock, and you have your desire. Adde it to 6 hours, and it gives you the time of the Suns being due West.

PROB. XVIII.

Latitude and Declination being as before, I demand the continuance of Twi-light.

THe continuance of Twi-light is *l* ♎; so that in the Triangle *l m* ♎, right angled at *m*, we have given,

l ♎ *m*, the Complement of the Poles Elevation;
And *l m*, the Suns depression below the Horizon.

} And *l* ♎ is required: It's 1 *ho.* 48′

PROB.

PROB. XIX.

Latitude and Declination as before, I demand the time of Day breaking, and Twi-light ending.

We have before found the time of the Suns rising to be	7 *ho.* 30′
From which substract the continuance of Twi-light (but now found)	1 *ho.* 48′
The Remainder is the time of the Days breaking	5 *ho.* 42′

For Twi-light ending; add the continuance of Twi-light, to the time of the Suns setting, and you have it (for as much as the Sun gives Light before he riseth) so much it will be after he sets, before we lose his light.

PROB. XX.

Latitude Southerly, 50 deg. 00 min. *Declination Southerly* 17 deg. 47 min. *I demand the Suns Amplitude of Rising and Setting.*

Fig. IV. THe Suns Amplitude of Rising and Setting is ♎ B, and you have in the Triangle B A ♎, B A the Suns Declination given, A ♎ B the complement of the Latitude; to find B ♎, I will only shew how things lie in the Scheme, and leave the practice of it to the Learner: ♎ B is required.

PROB. XXI.

To find the Suns height at Six of the Clock, having the same things given.

THe Suns height at the hour of 6, is O 6, and it falls in the right-angled Triangle ♎ O 6, wherein you have given O ♎ *b*, the Latitude; and ♎ 6 the Suns Declination; to find O 6.

PROB. XXII.

To find the Suns Azimuth at Six a clock.

THe Suns Azimuth at six of the Clock is 6 S = to R O ♎, so that in the right angled Triangle 6 O ♎, you have the Suns Declination and the Latitude given, to find O ♎ the Azimuth at 6 a clock.

PROB. XXIII.

To find the Suns height being due East or West.

THe Suns height when he is over the East point of the Compass, is R ♎, and in the Triangle R ♎ 6 (right angled at *b*) you have *b* ♎ R the Latitude, and R *b* the Suns Declination given, to find the Suns height being East or West ♎ R.

PROB. XXIV.

To find the Suns place in the Ecliptick.

HIs place in the Ecliptick is ♎ M, and you have the present Declination M L given, and the greatest Declination M ♎ L, to find the Suns place in the Ecliptick.

PROB. XXV.

The Suns right Ascention is ♎ L *in the same Triangle given, to find the difference of Ascention.*

THe difference of Ascention is B 6 = to A ♎, and in the Triangle B A ♎ you have the Suns Declination and the Complement of the Latitude given to find it.

PROB. XXVI.

For the length of the Day and Night.

ADd the differences of Ascention to 6 hours and double it, and you have the length of the Day, and that substracted from 24 hours gives the length of the Night.

PROB.

PROB. XXVII.

For the time of the Suns Riſing and Setting.

SUbſtract the difference of Aſcention 6 B from 6 hours, and the remainder is the time of the Suns Riſing; add it to 6 hours and it gives the time of the Suns ſetting.

PROB. XXVIII.

To find the time of the Suns being due Eaſt.

THe time of the Suns being due Eaſt is meaſured from 6 to ♈, = to *b* ♎, and is found in the right angled Triangle ♎ *b* R, add it to 6 hours (after it is converted into time) and you have your deſire: ſubſtract it from 6 hours and it gives the time of the Suns being due Weſt.

PROB. XXIX.

For the length of the longeſt Day in the year.

YOu muſt conceive the Sun to be in the Tropick of *Capricorn*, becauſe you are in a *South Latitude*; and it is found by the difference of Aſcention that day, as the longeſt day was found in a North Latitude.

The ſhorteſt day is the Complement of the longeſt day in that Latitude to 24 hours, = to which is the ſhorteſt Night or the ſhorteſt Day.

PROB. XXX.

The continuance of Twi-light.

IT is BN, = to ☉ ♎, and you have *e* W 18 *deg.* and *e* ♎ W, the Complement of the Latitude given, in the right angled Triangle ♎ W ☉ to find it.

PROB. XXXI.

For the time of Day breaking.

SUbstract the *continuance of Twi-light* from the time of the Suns rising (before found) and you have it.

Add the *continuance of Twi-light*, to the time of the Suns setting (before found) and you have the time of *Twi-light ending*. *Thus much for right angled Spherical Triangles.*

CHAP. XXXI.

The Doctrine of Oblique Spherical Triangles.

FOr the Resolution of the first two Cases of an Oblique Spherical Triangle, take this for an infallible Rule.

That the Sine of every Angle of a Spherical Triangle is proportional to the Sine of his opposite side; or, *The Sine of every side, is proportional to the Sine of his opposite Angle.*

So that the work is as easie (for these two first Cases) as for the same Cases in right lined Oblique Triangles; therefore I need say no more, but come to the Cases.

CASE. 1.

Two sides of an Oblique Spherical Triangle, with an Angle opposite to one of them given, to find the Angle opposite to the other.

ADmit (in the Scheme following) that there be given the Angle E Z P, which represents the Suns Azimuth from the North 124 *deg.* 45′ the Complement of the Latitude P Z 40 *deg.* 00′ the Complement of the Suns Declination E P 72 *deg.* 13′, and it were required to find Z E P the Angle of the Suns Position.

SUbſtract the *co*
ſing (before f
Add the *continua*
fore found) and yo
right angled Spheri

The Doctr

FOr the
Sph

That the Sine of eve
Sine of his oppoſit
Sine of his oppoſit

So that the wor
ſame Caſes in righ
more, but come to

Two ſides of an O
poſite to one of
other.

ADmit (in th
gle E Z P, v
124 *deg.* 45′ the
Complement of the
quired to find Z E

Fig. I.

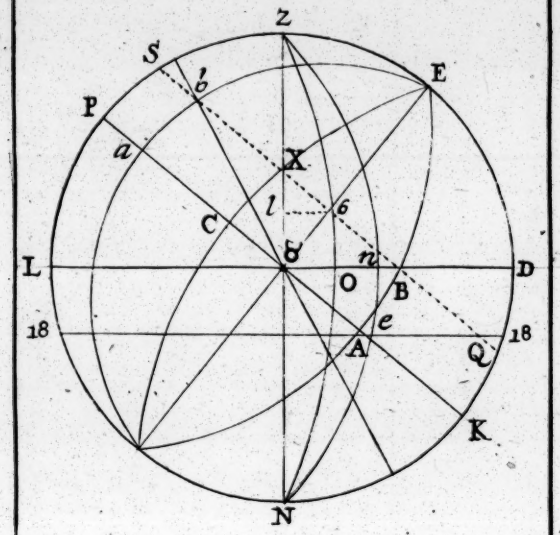


Fig. II.

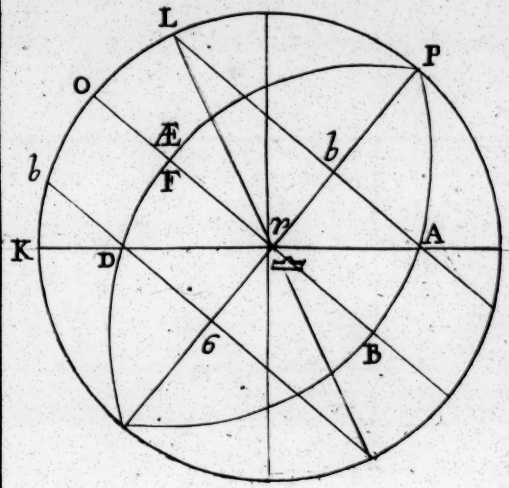


Fig. III.

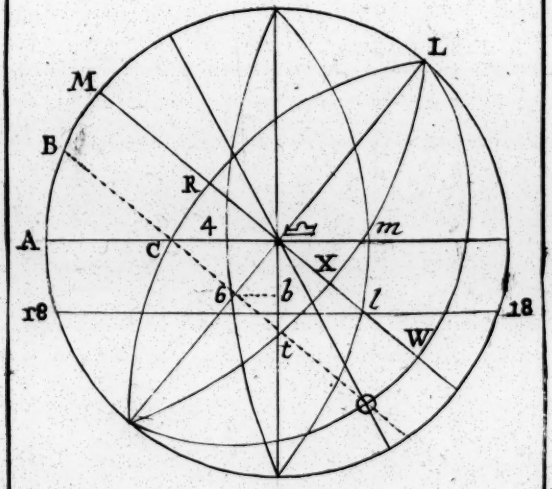
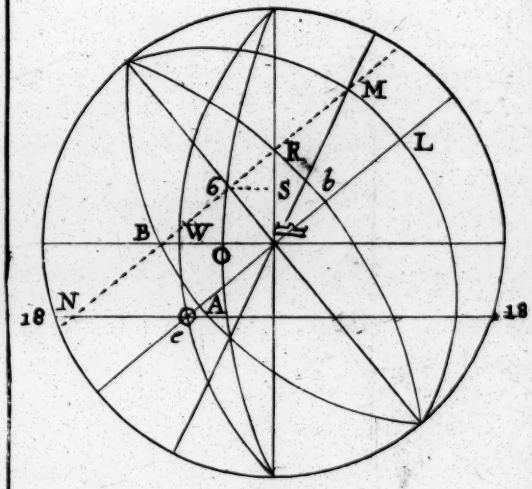


Fig. IV.



Against Page 276.

I say then,

As E P *s.* 72 *deg.* 13′ *co. ar.*	0.02126
Is to E Z P *s.* (its Comp. to 180 *deg.* E Z O) 55 *deg.* 15′	9.91468
So is Z P *s.* 40 *deg.* 00′	9.80806
To Z E P *s.* 33 *deg.* 41′	9.74400

CASE 2.

Two Angles, and a side opposite to one of them given, to find the side opposite to the other Angle.

In the same Triangle let their be given

P Z	40 *deg.* 00′
E	33 *deg.* 41′
O Z E	55 *deg.* 15′

} And let E P be required.

I say then,

As *s.* Z E P	33 *deg.* 41′ *co. ar.*	0.25601
To *s.* Z P	40 *deg.* 00′	9.80806
So *s.* E Z O	55 *deg.* 15′	9.91465
To *s.* E P	72 *deg.* 13′	9.97872

The reason of this is plain; for if you let fall the *Perpendicular* Z B from the obtuse Angle Z, it devides the Triangle into two right angled Triangles, namely Z B P and Z B E; I say then, that Z B and *Radius* is equal to the *s. co.* of Z P and P; because the *Perpendicular* is the middle part; and it is an opposite Extreme (in the Triangle Z B P) and this is proved by the first *General Axiome*, *That the Sine of the middle part with* Radius, *is* = *to the Sine Complement of the opposite Extremes.*

Now the same *Perpendicular* and *Radius* in the Triangle Z B E is = to Z P and P, and therefore also = to Z E and E, for there it's an opposite Extreme also, and in both the *Perpendicular* is the middle part, and so put with *Radius*; so that from hence it's evident that

Z P and P, is = to Z E and E (the two Extremes in one to the two Extreams in the other) and therefore they are proportional.

So

So that as Z P the *Hypotenuſe* in the one
Is to Z E the *Hypotenuſe* in the other,
So is P the *Angle* at the Baſe in the one
To E the *Angle* at the Baſe in the other.

At this rate then, if in one Triangle (right angled) you have given any things to find the *Perpendicular*; call them as you would do to find that; when you put them in reſpondency as here if you have given

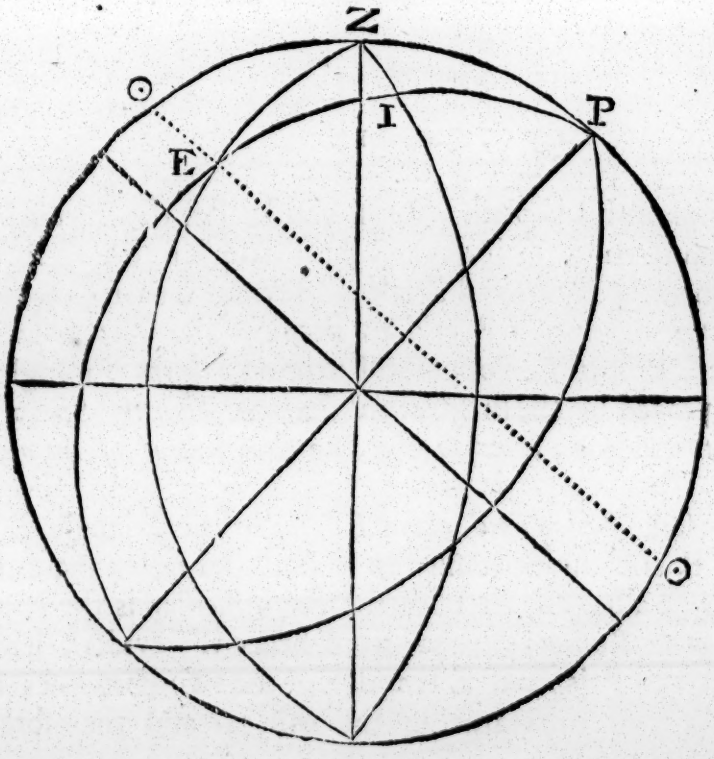
Z P and P, to find the *Perpendicular* Z B, you would ſay
s. Z B + *Radius*, is = to *s.* Z P + *s.* P.

Why then when you put things in reſpondency, I would ſay,

As *s.* Z P is in proportion to *s.* Z E
So is *s.* Z P E in proportion to *s.* Z E B } The like is to be underſtood of any other.

To avoid three Operations, we ſhall uſe this way through eight Caſes of an Oblique Triangle, and only point at the way of working by right angled Triangles (after the *Angle* is reduced to two right *Angles.*)

A general Scheme for Latitude 50 deg. 00 min. *Northerly, Declination Northerly* 17 deg. 47 min.



My

My intent is to use the Triangle E Z P for the resolving all the Cases of an Oblique Spherical Triangle; in which Z P is the Complement of the Poles Elevation, Z E is the Complement of the Suns Altitude, E Z P is the Suns Azimuth from the North; Z E P is the Suns *Angle* of Position, E P is the Complement of the Suns Declination, E P Z is the hour from Noon.

Of the eight Cases of an Oblique Spherical Triangle, *and how to resolve them either at two or three Operations (which you please.)*

By letting fall a Perpendicular from any side of a Triangle, you divide it into two Right Angles; and to do it for your advantage in working, pray observe this Caution:

Let it fall so, that in one of the Right Angles Triangles, you may have two of the given things entire, and the third (as often as you can) entire in the other, or else be sure they be part in one, and part in the other.

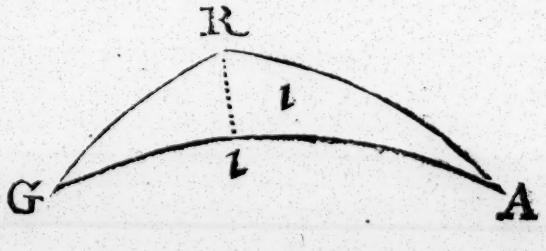
CASE 3.

Two Sides and the contained Angle given, to find the other Angles.

IN the Triangle A R G (represented in the Scheme preceding, by E Z P) let there be given,

The side A R 40 *deg.* 00′
The side A G 72 *deg.* 13′
The Angle at A 42 *deg.* 27′
} And let it be required to find the Angles G and R.

Let fall the Perpendicular R I within the Triangle, from the Obtuse Angle at R, and it resolves the Oblique Triangle G R A into two Right Angles, namely G I R, and R I A.



In

In the right angled Triangle A I R, I have given,

	d.	*m.*	
The Angle at A	42	27	*s.* R I + *Radius*, is = to *s.* R A + *s.* A.
The side A R	40	00	
To find the Perpendicular I R.			

s. R A 40 *deg.* 00′	9.80806	The Perpendicular R I then is 25 *deg.* 43′.
s. A 42 *deg.* 27′	9.82926	
s. I R 25 *deg.* 43′	9.63732	

Next I'll find I A, with the same things given.

Data. A 42 *deg.* 27′ / A R 40 *deg.* 00′ / Required I A. } *s. co.* A + *Radius*, = *t.* A I + *t. co.* A R

t. co. A R 40 *deg.* 00′, *co. ar.*	9.92381
s. co. A 42 *deg.* 27′	9.86797
t. A I 31 *deg.* 46′	9.79178

Which substracted from A G	72 *deg.* 13′
Leaves I G	40 *deg.* 27′

Lastly, For the Angle at G.

Data. R I 25 *deg.* 43′ / G I 40 *deg.* 27′ } Required G.

t. I R 25 *deg.* 43′, *co. ar.*	0.31729
s. I G 40 *deg.* 27′	9.81210
t. co. G 36 *deg.* 35′	10.12939

And thus the Angle at G is found to be 36 *deg.* 35′ (neareſt) by reſolving the Triangle into two Right Angles, and working by the *General Axiome.* But there is a nearer way (as I have hinted, and laid down the proportion before): for when I have found A I, and ſo I G, which ſhould have been the firſt things found (for in this caſe of reſpondency we do not find the Perpendicular at all;) but I conſider

ſider what I ſhall call A, and A I, in the right angled Triangle A I R, to find the Perpendicular R I, and the ſame I will call them, to put them in reſpondency with I G and G, the *Baſe* and *Angle at the Baſe* in the Triangle R I G.

Data. { A I, A, Required R I } *s.* I A + *Radius*, is = to *t. co.* A + *t.* I R.

I'll ſay then,

As *s.* I A the Arch found	31 *deg.* 46′,	*co. ar.*	0.27863
Is to *s.* I G the ſecond Arch	40 *deg.* 27′		9.81210
So is *t. co.* A	42 *deg.* 27′		10.03870
To *t. co.* G	36 *deg.* 35′		10.12943

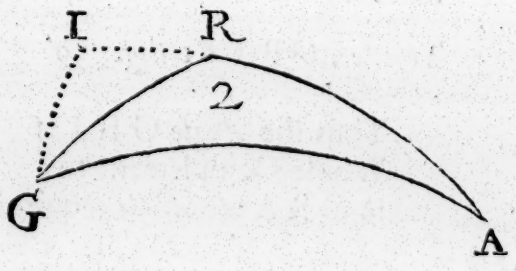
Thus the Angle G is found at two Operations; but we ſhall touch at both ways, for ſome will like one of theſe ways, and ſome the other.

Example 2. *To find the Angle at* R.

Admit we have given, as before,

The ſide A R	40 *deg.* 00′	And let G R A be required.
The Angle at A	42 *deg.* 27′	
The ſide A G	72 *deg.* 13′	

In this caſe, 'tis the beſt way to let fall the Perpendicular without the Triangle (as G I is) for then you have the Oblique Triangle reduced into two Right Angles, namely G I R and G I A, both right angled at I.



And in the Triangle G I A, we have given A G 72 *deg.* 13′
And the Angle at A 42 *deg.* 27′
Whereby we may find the Arch A I.

s. co. A + *Radius*, is = to *t.* A I + *t. co.* A G.

t. co. A G	72 *deg.* 13′,	*co. ar.*	0.49384
s. co. A	42 *deg.* 27′		9.86797
t. A I	66 *deg.* 30′		10.36181

If from A I now found	66 *deg.* 30′
You ſubſtract A R	40 *deg.* 00′
The remainder is R I	26 *deg.* 30′

This done, conſider which will be the reſpondent things to find the *Angle* G R I; and I find that I have A I the *Baſe* in the Triangle G I A, and the *Baſe* I R in the little Triangle G I R. Alſo the *Angle* at the *Baſe* in the great Triangle (namely A) reſpondent to the *Angle* at the *Baſe* in the little Triangle G R I. So that now we'll conſider what we ſhall call A I, and the *Angle* at A (in the great Triangle) to find the Perpendicular; and I will call them ſo, to put them in reſpondenſes.

Secondly.

Data. { A I / A / I G } *s.* I A + *Radius*, is = to *t. co.* A + *t.* I G.

As *s.* I A	66 *deg.* 30′	*co. ar.*	0.03760
Is to *s.* R I	26 *deg.* 30′		9.64952
So is *t. co.* A	42 *deg.* 27′		0.03870
To *t. co.* G R I	61 *deg.* 59′		9.72582

Thus the *Angle* G R I is	659	00
Whoſe Complement to	180	00
Is G R A the *Angle* required	118	01

But if in the ſecond place you had found the Perpendicular, then in the Triangle G R I we ſhould have had the Perpendicular I G given, and the Baſe I R (before found) whereby we may find the *Angle* G R I.

Example

Example: *First, for the Perpendicular* G I.

s. A I	66 *deg.* 30′		9.96239
t. co. A	42 *deg.* 27′	*co. ar.*	9.96129
t. I G	39 *deg.* 59′		9.92368

Secondly, *for the Angle* G R I.

Data. { G I 39 *deg.* 59′ / R I 26 *deg.* 30′ } *s.* R I + *Radius*, is = to *t. co.* G R I + *t.* G I
{ Required G R I }

t. G I	39 *deg.* 59′	*co. ar.*	0.07644
s. R I	26 *deg.* 30′		9.64952
t. co. G R I	61 *deg.* 59′		9.72596

In the like manner it will fall out, that you may resolve (as I said before) all the Cases but two (both of right angled and oblique angled Triangles) by that one *General Axiome.*

The Sine of the middle part with Radius, &c.

I intend onely to point at the resolving the Cases at Operations; and to do them onely at two.

CASE 4.

Two Sides and their contained Angle given, to find the third Side.

In the Triangle G R A, let there be given as before.

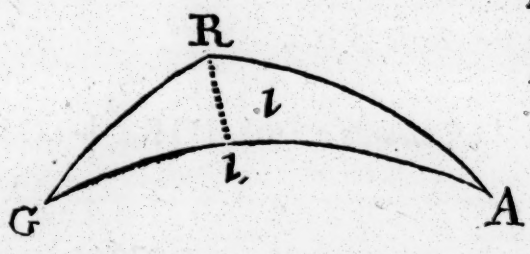
R A 40 *deg.* 00′
A G 72 *deg.* 13′ } And let the side R G be required.
A 42 *deg.* 27′

I'll let fall the Perpendicular from the *Angle* at R within the Triangle, and it falls upon the side G A at I, and divides the Triangle into the two right angled Triangles A I R and G I R; and we have given in the Triangle A I R (Triangle 1.)

The side A R 40 *deg.* 00′
The *Angle* A 42 *deg.* 27′ } And let the *Arch* A I be required.

s. co. A + *Radius*, is = to *t. co.* A R + *t.* A I.

R A *t.co.* 40 *d.* 00′ *co.ar.* 9.92381
A *s. co.* 42 *d.* 27′ 9.86797
A I *t.* 31 *d.* 46′ 9.79178



From A G 72 *deg.* 13′
Substract A I 31 *deg.* 46′
The remain. is G I 40 *deg.* 27′

I consider now, that I A the Base in the Triangle I A R is respondent to I G, the Base in the Triangle G I R; and that R A is respondent to G R the thing required: and therefore consider what I should call A R and I A, to find the *Perpendicular*, and will call them so to put them in respondency.

s. co. A R
s. co. I A } Therefore
As *s. co.* I A *co. ar.* 31 *deg.* 46′ 0.07047
To *s. co.* I G 40 *deg.* 27′ 9.88136
So *s. co.* A R 40 *deg.* 00′ 9.88425
To *s. co.* R G 46 *deg.* 43′ 9.83608

But instead of working of it in respondency, we might have found the *Perpendicular* in the second place; and then we had I R and I G in the Triangle G I R, to have found G R (in the third place:) but the working things in respondency is better.

Example 2.

Admit there be given (in Triangle the second)

	deg.	*min.*	
R A	40	00	And let it be required
The side R G	46	43	to find the side G A.
The *Angle* at R, namely G R A	118	00	

In

In this case I let fall the *Perpendicular* either from G or A without the Triangle, as in this second Triangle, and then in the right angled Triangle G I R, I have given,

G R 46 *deg.* 43′
G R I 62 *deg.* 00′
(The Comp. of G R A to 180 *d.*) } Whereby I may find the *Arch* I R.

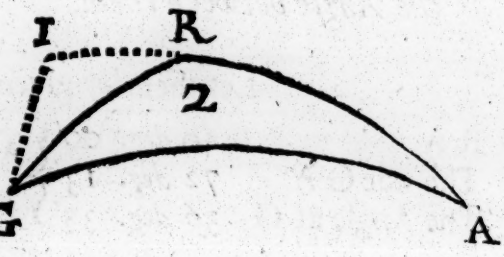
s. co. R + *Radius*, is = to *t. co.* G R + *t.* R I.

t. co. G R 46 *d.* 43′ *co. ar.* 0.026039
s. co. I R G 62 *d.* 00′ 9.671609

t. R I 26 *d.* 30′ 9.697648

To R A 40 *d.* 00′
If you adde the *Arch* R I 26 *d.* 30′

The sum is I R A 66 *d.* 30′

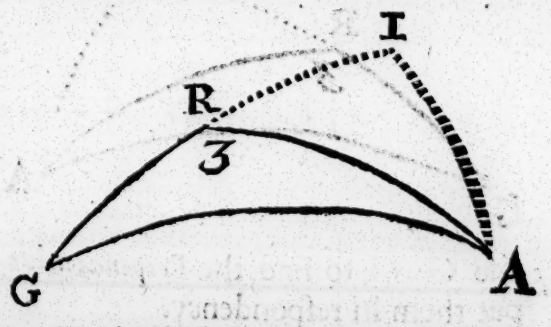


I consider now that R I the Base in the little Triangle G I R, is given me, and its respondent is A R I the Base in the great Triangle G I A, (which is given me too;) also G R is given me in the little Triangle (it's the Hypotenuse) and respondent to G A the Hypotenuse in the greater Triangle, and the thing required: and therefore I consider what I should call I R and R G, to find the *Perpendicular*; and so I call them to put them in respondency.

s. co. R G
s. co. I R } Therefore

As *s. co.* I R	26 *deg.* 30′	*co. ar.*	0.04820
Is to *s. co.* I A	66 *deg.* 30′		9.60069
So is *s. co.* G R	46 *deg.* 43′		9.83607
To *s. co.* G A	72 *deg.* 13′	required	9.48496

But if you had found the *Perpendicular* (in the second place) then in the third place you would have had I A, and I G, to have found the side required G A, in the great Triangle G I A.



In this case you might have let fall the *Perpendicular*, as here in this third Triangle, from the *Angle* at

at A, and so you would have had A R and A R I (the Complement of G R A to 180 *deg.*) to have found R I (the Base in the little Triangle R I A;) that found, you have it, and R A respondents to I G, and A G in the great Triangle, which would have done the same thing.

CASE 5.

Two Sides, with an Angle opposite to one of them, given, to find the Angle between them.

Let there be given in the Triangle 3.

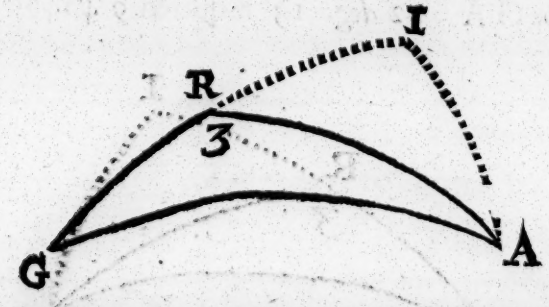
R A	40 *deg.* 00′	And let it be required to find the *Angle* at A.
The side G A	72 *deg.* 13′	
The Angle at G	36 *deg.* 35′	

If you let fall the *Perpendicular* without the Triangle (as here in the third Triangle) then you have given in the Triangle G I A (right angled at I)

The side G A	72 *deg.* 13′	Whereby we may find the *Angle* G A I.
The *Angle* at G	36 *deg.* 35′	

s. co. G A + *Radius*, is = to *t. co.* G + *t. co.* G A I.

G *t. co.*	36 *deg.* 36′	*co. ar.*	9.87079
G A *s. co.*	72 *deg.* 13′		9.48489
G A I *t. co.*	77 *deg.* 14′		9.35568



I consider now, that G A in the great Triangle is respondent to A R in the little Triangle (being both the Hypotenuses) and G A I in the great Triangle is respondent to R A I in the little one. I see then what I should call G A and G A I to find the *Perpendicular* A I; and the same I call them, to put them in respondency.

s. co.

s. co. G A I *t. co.* G A	Therefore	As *t. co.* G A	72 *deg.* 13′	*co. ar.*	0.49384
		Is to *t. co.* A R	40 *deg.* 00′		0.07618
		So *s. co.* G A I	77 *deg.* 14′		9.34435
		To *s. co.* R A I	34 *deg.* 47′		9.91437

From G A I 77 *deg.* 14′
Substract R A I 34 *deg.* 47′
The rema. is G A R 42 *deg.* 27′

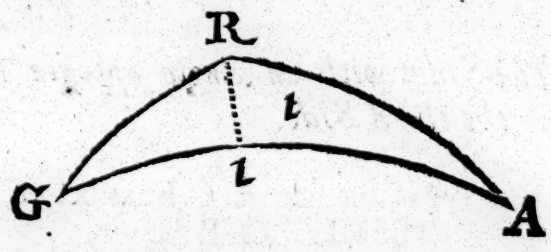
By reason of the neglect of the fractions of a minute in each side and *Angle*, this is near one minute out.

Example the Second.

Let A R be given 40 *deg.* 00′
The side G R 46 *deg.* 43′
The Angle at A, namely G A R 42 *deg.* 27′

And let the *Angle* G R A be required.

In this case we let fall the *Perpendicular* within, as in the first Triangle, and so we shall have A R, and the *Angle* at A given (in the right angled Triangle A I R) to find A R I.



Data: A R 40 *deg.* 00′; A 42 *deg.* 27′; I R A required.

s. co. R A + *Radius*, is = to *t. co.* A + *t. co.* A R I.

t. co. A	42 *deg.* 27′	*co. ar.*		9.96129
s. co. R A	40 *deg.* 00′			9.88425
t. co. A R I	54 *deg.* 59′			9.84554

Next, I consider that I have given in the Triangle A I R, the side A R, and A R I. These being respondent to R G given in the Triangle G R I, and G R I the other part of the *Angle* G R A required; I consider then what I should call A R and I R A, to find the *Perpendicular* R I, and the same I call them in respondency.

s. co.

s. co. I R A, *t. co.* R A	Therefore	As *t. co.* R A	40 *deg.* 00′	*co.ar.*	9.923813
		Is to *t.co.* R G	46 *deg.* 43′		9.973960
		So is *s.co.* I R A	54 *deg.* 59′		9.758771
		To *s. co.* I R G	63 *deg.* 01′		9.656544

But if you had found the *Perpendicular*, as you might have done (in the second place) then would you have had G R and the *Perpendicular*, (in the Triangle G I R) to have found G R I.

Add I R G thus found to be	63 *deg.* 01′
To I R A before found to be	54 *deg.* 59′
And you have G R A the *Angle* requir'd	118 *deg.* 00′

CASE 6.

Two Sides with an Angle oppoſite to one of them given, to find the third Side.

Let the ſide A G be as before	72 *deg.* 13′
The ſide G R be	46 *deg.* 43′
The *Angle* at A namely R A G be	42 *deg.* 27′
And let the ſide A R be required.	

Let fall the *Perpendicular* as in this ſecond Triangle from G, and ſo in the right angled Triangle A I G I have given.

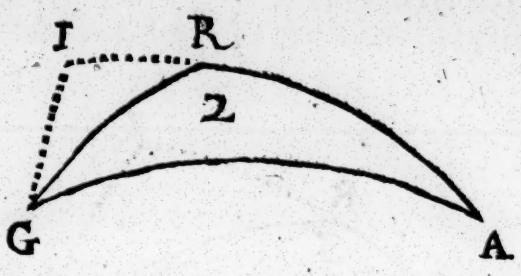
A G	72 *deg.* 13′	Whereby I may find the Arch
A	42 *deg.* 27′	A I.

s. co. A + *Radius*, is = to *t. co.* A G + *t.* A I

t. co. A G	72 *deg.* 13′	*co. ar.*	0.49384
s. co. A	42 *deg.* 27′		9.86797
t. A I	66 *deg.* 30′		10.36181

Now

Now I have given G A the Hypotenuſe in the great Triangle, and its Reſpondent G R in the little Triangle; alſo A I the Baſe in the great Triangle, Reſpondent to R I the Baſe in the little Triangle, whereby I may find R I, which being done, ſubſtraſt it from I A, and the remainder is R A, the ſide required.



Example.

I conſider what A G and A I muſt be called, to find the *Perpendicular*, and the ſame I call them to put them in reſpondency.

G A *s. co.*	Therefore	As *s. co.* G A	72 *deg.* 13′ *co. ar.*	0.51510
A I *s. co.*		Is to *s. co.* R G	46 *deg.* 43′	9.83607
		So *s. co.* A I	66 *deg.* 30′	9.60069
		To *s. co.* R I	26 *deg.* 30′	9.95185

From the Arch A I firſt found	66 *deg.* 30′
Subſtract I R here found	26 *deg.* 30′
And you have R A the ſide required	40 *deg.* 00′

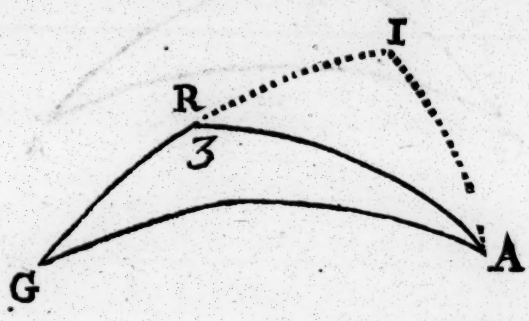
Here inſtead of putting things in reſpondency, you might have found the *Perpendicular* in the ſecond place, and ſo you would have had G R and G I given in the little Triangle G I R to find R I.

Example the Second.

Let there be given the ſide A R 40 *d.* 00′
The ſide A G 72 *d.* 13′
And let the *Angle* at R namely G R A be 118 *d.* 00′
} And let the ſide G R be required in the third Triangle.

If you let fall the *Perpendicular* from A, as A I; then you have given in the Triangle A R I (right angled at I)

The ſide A R 40 *deg.* 00′
The *Angle* G R A } 62 *deg.* 00′ } Whereby you may find the Arch IR
Its *co.* to 180*d.* A R I }



	d.	*m.*	
s. co. R	62	00	9.671609
t. R A	40	00	9.923813
t. R I	21	31	9.595422

I conſider what A R and R I muſt be called to find the *Perpendicular*, and ſo I call them to put them in reſpondency.

As *s. co.* A R	40 *deg.* 00′	*co. ar.*	0.11574
To *s. co.* A G	72 *deg.* 13′		9.48489
So *s. co.* R I	21 *deg.* 30′		9.96867
To *s. co.* I G	68 *deg.* 14′		9.56930

From I G 68 *deg.* 14′
Subſtract I R 21 *deg.* 31′

The remaind. is R G 46 *deg.* 43′

Here in the ſecond place inſtead of putting things in reſpondency, you might have found the *Perpendicular*; and then you would have had I A and A G to have found G I in the right angled Triangle G I A.

CASE 7.

Two Angles and the Side between them given, to find the third Angle.

Let there be given in the firſt Triangle G R A
The *Angle* at A 42 *deg.* 27′
The *Angle* at R 118 *deg.* 00′ its Comp. to 180 *deg.* is A R I 62 *deg.* 00′
The ſide R A 40 *deg.* 00′
And let it be required to find the *Angle* at G.

To

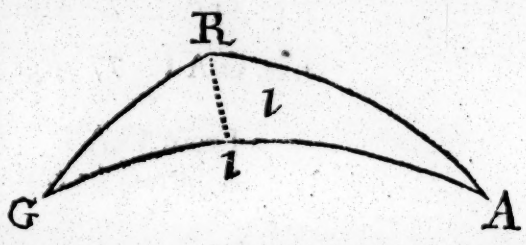
• To reſolve this Queſtion, let fall the *Perpendicular* within the Triangle as you ſee in Triangle firſt and then in the right angled Triangle A I R we have given

A R	40 *deg.* 00′	Whereby we may find A R I
A	42 *deg.* 27′	

t. A	42 *deg.* 27′	9.96129
s. co. A R	40 *deg.* 00′	9.88425
t. co. I R A	54 *deg.* 59′	9.84554

From	118 *deg.* 00′	G R A
Subſtract	54 *deg.* 59′	I R A
The remainder is	63 *deg.* 01′	I R G

Now you have A and A R I in the Triangle A I R given, and they are reſpondent to G R I, and the *Angle* at G, ſo that I ſee what I muſt call A, and A R I, to find the *Perpendicular*, and the ſame I call them to put them in reſpondency.



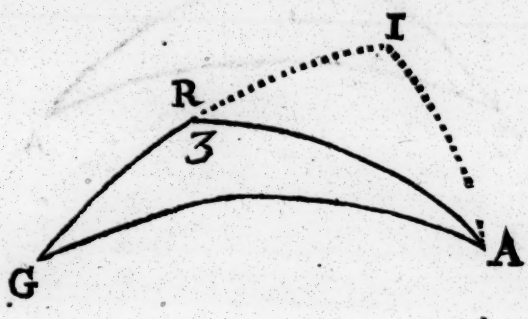
Data. { A, A R I, R I req. } *s. co.* A + *Radius* is = to *s.* A R I + *s. co.* R I.

I ſay then;

As *s.* A R I	54 *deg.* 59′ *co. ar.*	0.08672
Is to *s.* G R I	63 *deg.* 01′	9.94994
So is *s. co.* A	42 *deg.* 27′	9.86797
To *s. co.* G	36 *deg.* 35′	9.90463

Here in the ſecond place you might have found the *Perpendicular*, and ſo you would have had R I and G R I to have found the *Angle* at G (in the right angled Triangle R I G)

The side A R 40 *deg.* 00′
The *Angle* G R A } 62 *deg.* 00′ } Whereby you may find the Arch IR
Its *co.* to 180*d.* A R I }



	d.	*m.*	
s. co. R	62	00	9.671609
t. R A	40	00	9.923813
t. R I	21	31	9.595422

I consider what A R and R I must be called to find the *Perpendicular*, and so I call them to put them in respondency.

As *s. co.* A R	40 *deg.* 00′	*co. ar.*	0.11574
To *s. co.* A G	72 *deg.* 13′		9.48489
So *s. co.* R I	21 *deg.* 30′		9.96867
To *s. co.* I G	68 *deg.* 14′		9.56930

From I G 68 *deg.* 14′
Substract I R 21 *deg.* 31′

The remaind. is R G 46 *deg.* 43′

Here in the second place instead of putting things in respondency, you might have found the *Perpendicular*; and then you would have had I A and A G to have found G I in the right angled Triangle G I A.

CASE 7.

Two Angles and the Side between them given, to find the third Angle.

Let there be given in the first Triangle G R A
The *Angle* at A 42 *deg.* 27′
The *Angle* at R 118 *deg.* 00′ its Comp. to 180 *deg.* is A R I 62 *deg.* 00′
The side R A 40 *deg.* 00′
And let it be required to find the *Angle* at G.

To

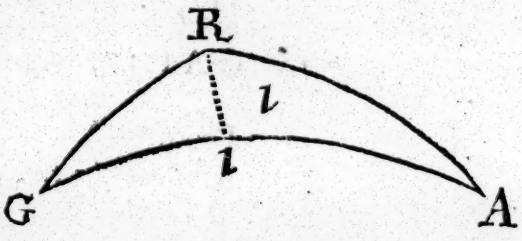
To resolve this Question, let fall the *Perpendicular* within the Triangle as you see in Triangle first and then in the right angled Triangle A I R we have given

A R	40 *deg.* 00′	Whereby we may find A R I
A	42 *deg.* 27′	

t. A	42 *deg.* 27′	9.96129
s. co. A R	40 *deg.* 00′	9.88425
t. co. I R A	54 *deg.* 59′	9.84554

From	118 *deg.* 00′	G R A
Substract	54 *deg.* 59′	I R A
The remainder is	63 *deg.* 01′	I R G

Now you have A and A R I in the Triangle A I R given, and they are respondent to G R I, and the *Angle* at G, so that I see what I must call A, and A R I, to find the *Perpendicular*, and the same I call them to put them in respondency.



Data. { A, A R I, R I req. } *s. co.* A + *Radius* is = to *s.* A R I + *s. co.* R I.

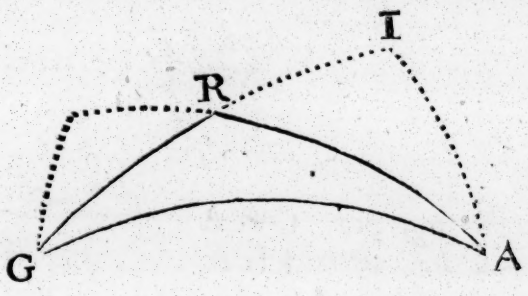
I say then;

As *s.* A R I	54 *deg.* 59′ *co. ar.*	0.08672
Is to *s.* G R I	63 *deg.* 01′	9.94994
So is *s. co.* A	42 *deg.* 27′	9.86797
To *s. co.* G	36 *deg.* 35′	9.90463

Here in the second place you might have found the *Perpendicular*, and so you would have had R I and G R I to have found the *Angle* at G (in the right angled Triangle R I G)

Example the Second.

Data. { A G 72 *deg.* 13′ / R A G 42 *deg.* 27′ } Required G R A
G 36 *deg.* 35′



To resolve this Question, you may let fall the *Perpendicular* either from A or G, it's indifferent which, (but here we use it as let fall from A) and in the Triangle A G I we have given A G and G } To find G A I.

t. G	36 *deg.* 35′	9.87052
s. co. G A	72 *deg.* 13′	9.48489
t. co. G A I	77 *deg.* 14′	9.35541

From G A I	77 *deg.* 14′
Substract G A R	42 *deg.* 27′
The remainder is R A I	34 *deg.* 47′

So that now we have G and G A I in the Triangle G I A given; and they are respondent to R A I (given in the little Triangle) and the required *Angle* (its Complement to 180 *deg.* 00′ A R I.

We may say then,

As *s.* G A I	77 *deg.* 14′ *co. ar.*	0.01090
Is to *s.* R A I	34 *deg.* 47′	9.75623
So is *s. co.* G	36 *deg.* 35′	9.90471
To *s. co.* A R I	61 *deg.* 59′	9.67184

We might have found the *Perpendicular* in the second place, and so we should have had I A and R A I to have found A R I the *Angle* required (in the Triangle A R I)

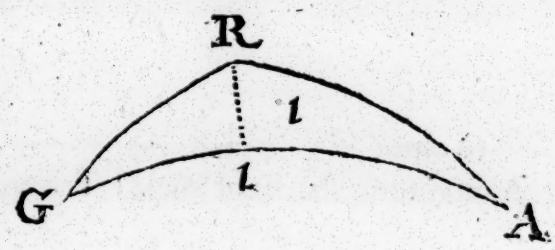
CASE

CASE 8.

Two Angles and the Side between them given to find one of the other Sides.

Let there be given in the Triangle G R A

The *Angle* at R 118 *deg.* 00′
The *Angle* at A 42 *deg.* 27′
The ſide A R 40 *deg.* 00′
And let R G be required.



Here let fall the *Perpendicular* from R, and then in the Triangle A R I (right angled at I) we have given A R and the *Angle* at A, whereby we may find the *Angle* I R A.

s. co. R A + *Radius*, is = to *t. co.* A + *t. co.* I R A.

t. A	42 *deg.* 27′	9.961291
s. co. A R	40 *deg.* 00′	9.884254
t. co. I R A	54 *deg.* 59′	9.845545

From G R A	118 *deg.* 00′
Subſtract I R A now found	54 *deg.* 59′
And the remainder is I R G	63 *deg.* 01′

Now we have Given A R and I R A, in the Triangle A I R, which is reſpondent to I R G (given in the Triangle) and R G required: I conſider what I muſt call A R and I R A, to find the *Perpendicular*: and the ſame I call them to put them in reſpondency.

t. co. R A *s. co.* I R A	Therefore	As *s. co.* I R A 54 *deg.* 59′ *co. ar.*	0.24122
		Is to *s. co.* I R G 63 *deg.* 01′	9.65676
		So is *t. co.* A R 40 *deg.* 00′	10.07618
		To *t. co.* R G 46 *deg.* 43′	9.97416

But

But in the second place, with A R and I R A, you might have found the Perpendicular; and so you would have had R I and G R I in that Triangle, to have found R G required.

Example the Second.

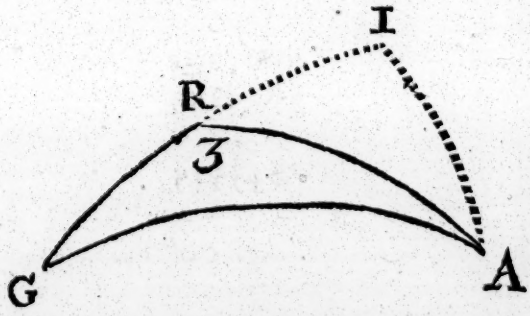
Let there be given, as before,

The *Angle* at R, namely G R A 118 *d.* 00′ Its Comp. to 180 *d.* is

The *Angle* A R I 62 *deg.* 00′
R A 40 *deg.* 00′
G A R 42 *deg.* 27′
} And let A G be required.

In this Case, let fall the Perpendicular without the Triangle from A, and so in the right angled Triangle A R I, we have given,

	d.	*m.*	
A R	40	00	*s. co.* R A + *Radius*, is = to *t. co.* I R A + *t. co.* R A I.
A R I	62	00	
To find R A I.			



t. I R A	62 *d.* 00′	0.27432
s. co. R A	40 *d.* 00′	9.88425
t. co. R A I	34 *d.* 46′	10.15857

To the *Ang.* given G A R	42 *d.* 27′
I add this *Angle* found	34 *d.* 46′
And it makes the *Angle* I A G	77 *d.* 13′

We have now in the Triangle R A I (right angled at I) the side R A, and R A I given; which things are respondent to the given *Angle* G A I, and the required side G A (in the Triangle G I A;) I consider what R A and R A I must be called, to find the *Perpendicular*, and so I call them to put them in respondency.

t. co. R A	Therefore	As *s. co.* R A I	34 *deg.* 46′	*co. ar.*	0.08540
		Is to *s. co.* I A G	77 *deg.* 13′		9.34491
s. co. R A I		So is *t. co.* R A	40 *deg.* 00′		10.07618
		To *t. co.* A G	72 *deg.* 13′		9.50649

If

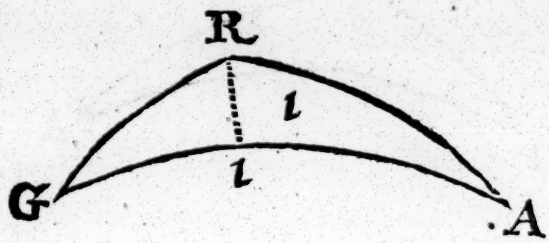
If you have a mind, you may (in this second place) find the *Perpendicular*, with R A and R A I given in the Triangle R A I; and then with the *Perpendicular* given, and I A G (in that great Triangle) you may find (at the third Operation) the side G A required here.

CASE 9.

Two Angles, and a Side opposite to one of them given; to find the Side between them.

Let there be given the *Angle* at G, and the *Angle* at A, and the Side R A; and let the Side G A be required.

G is 36 *d.* 35′
A is 42 *d.* 27′
R A is 40 *d.* 00′
} G A is requ.



If fall the *Perpendicular* within the Triangle from R, and so in the Triangle A I R, we have given,

A R	40 *deg.* 00′	*t.*	9.92381
A	42 *deg.* 27′	*s. co.*	9.86797
A I	31 *deg.* 46′	*t.*	9.79178

I see what I must call A and I A, to put them in respondency with G and G I.

t. co. A
s. co. A I
} Therefore

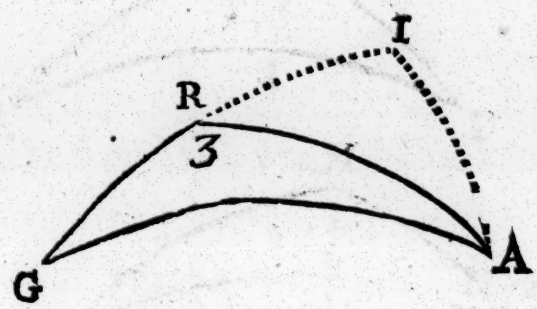
As *t. co.* A	42 *deg.* 27′	9.96129
To *t. co.* G	36 *deg.* 35′	10.12947
So *s.* A I	31 *deg.* 46′	9.72136
To *s.* I G	40 *deg.* 27′	9.81212

Adde I G here found	40 *deg.* 27′
To A I before found	31 *deg.* 46′
The sum is G A the side required	72 *deg.* 13′

Example

Example 2.

Let the *Angle* G be given, as before, to be 36 *deg.* 35′
The *Angle* at R (its Compl. to 180 deg. A R I) be 62 *deg.* 00′
The Side G A 72 *deg.* 13′
And let the Side G R be required.



First, for the *Arch* G I.

Data. { G A, G, G I requ. } *s. co.* G + R is = to *t.* A G + *t.* G I

t. G A	72 *d.* 13′	0.49384
s. co. G	36 *d.* 35′	9.90471
t. G I	68 *d.* 14′	10.39855

I consider now I have I G A given, and G I in the great Triangle G I A, that are respondent to the given *Angle* A R I, and R I.

Consider what you must call G I and G, to find the Perpendicular.

As *t.* A G I	36 *deg.* 35′	9.87052
To *t. co.* A R I	62 *deg.* 00′	9.72567
So *s.* G I	68 *deg.* 14′	9.96787
To *s.* R I	21 *deg.* 31′	9.56406

This I R	21 *deg.* 31′
Substract from G I	68 *deg.* 14′
Leaves G R	46 *deg.* 43′

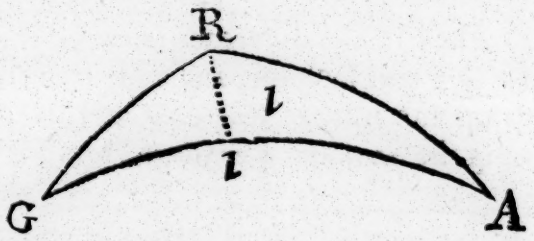
Thus the required Side is 46 *deg.* 43′

CASE

CASE 10.

Two Angles, and a Side opposite to one of them, given; to find the third Angle.

Let there be given,
The *Angle* at A 42 *deg.* 27′
The *Angle* at G 36 *deg.* 35′
The Side G R 46 *deg.* 43′
I demand the *Angle* G R A.



Here I have G R and G given me, (in the right angled Triangle G I R) whereby I may find G R I.

t. G	36 *deg.* 35′	9.87052
s. co. G R	46 *deg.* 43′	9.83607
t. co. G R I	63 *deg.* 02′	9.70659

Next, for the *Angle* I R A.

As *s. co.* G	36 *deg.* 35′	*co. ar.*	0.09528
To *s. co.* A	42 *deg.* 27′		9.86797
So *s.* G R I	63 *deg.* 02′		9.95000
To *s.* I R A	54 *deg.* 59′		9.91325

This *Angle* I R A	54 *deg.* 59′
Added to the *Angle* G R I	63 *deg.* 02′
Makes the *Angle* required G R A	118 *deg.* 01′

These be the Eight Cases of a *Spherical Triangle*, which are resolved by letting fall the Perpendicular from some one *Angle* thereof. There be two Cases more, which may be resolved by letting fall a Perpendicular; and not onely that way, but several other ways, as is largely and very plainly demonstrated in my Father's Book, called *The Doctrine of Triangles*. I think nothing of so high a nature can be plainer demonstrated, than the reason of the *Rule* it self. I refer the Reader to

that for variety, and ſhall onely uſe one of them ways as a choice way to me; though to others the reſt may ſeem as plain, and indeed are.

CASE II.

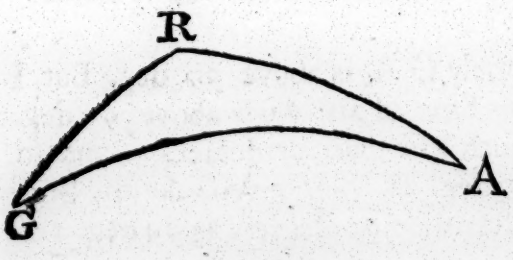
The three Sides of a Triangle given, to find an Angle.

TAke half the difference between the two ſides that contain the *Angle* you look for, and adde it to half the other ſide (which muſt be oppoſite to that *Angle*;) and likewiſe ſubſtract it from the ſame, noting the *Sum* and *Remainder*.

Then, this is the RULE.

To the Complements Arithmetical of the Sines of the Sides that contain the required Angle, adde the Sines of the Sum and Remainder (before noted) *and the half of that Sum or Total, ſhall be the Artificial Sine of half the Angle required.*

Example, in the Triangle G R A.



Let there be given in the Triangle G R A,

R G 46 *d.* 43′ } And let the
A R 40 *d.* 00′ } *Angle* A be
A G 72 *d.* 13′ } required.

A G is	72 *deg.*	13′
R A is	40 *deg.*	00′
Their difference	32 *deg.*	13′
The ½ difference is	16 *deg.*	6′ ½

		d.	*m.*
G R oppoſite to A, is 46 *deg.* 43′	the half of it is	23	21 ½
The half difference being added,	½ difference	16	06 ½
Gives the ſum;	ſum	39	27
Subſtracted, it leaves for the remainder,	remainder	07	15

	d.	*m.*		
R A *s.*	40	00	*co. ar.*	0.19193
G A *s.*	72	13	*co. ar.*	0.02126
Sum *s.*	39	27		9.80305
Remainder *s.*	07	15		9.10105
			Total	19.11729

½ A *s.*	21 *deg.*	13′ ½	½ Total	9.55864
Doubled is	42 *deg.*	27′	The *Angle* at A required.	

Example the Second.

Fig. I. ADmit in the Triangle G A R, in this Scheme following, we have given,

	d.	*m.*
A R the Complement of the Latitude	40	00
R G the Complement of the Suns height	79	00
A G the Complement of the Suns Declination	99	10

And let the *Angle* at A (which is the hour from Noon) be required.

In this case, one of the sides, namely G A, is above 90 deg. But I would have you remember that the Sine of an *Angle* above 90 deg. is also the Sine of an *Angle* as much less than 90 degrees; and so when you would take the Sine of 99 deg. 10′ here given, take the Sine of 80 deg. 50′; which is as much less than 90 degrees, as 99 deg. 10′ is more.

	d.	*m.*
The side A G is	99	10
The side A R is	40	00
The difference is	59	10
The half-difference is	29	35

	d.	*m.*
G R is	79	00
The half of G R is	39	30

	d.	m.		d.	m.			
½ GR	39	30	RA	40	00	co. ar.	s.	0.19193
½ Difference	29	35	AG	99	10	co. ar.	s.	0.00558
Sum	69	05	Sum	69	05		s.	9.97039
Remainder	09	55	Remainder	09	55		s.	9.23607
								19.40397
			The half of A is	30	deg.	13′ ½		9.70198
						2		
			Which doubled, is A	60	deg.	27′		

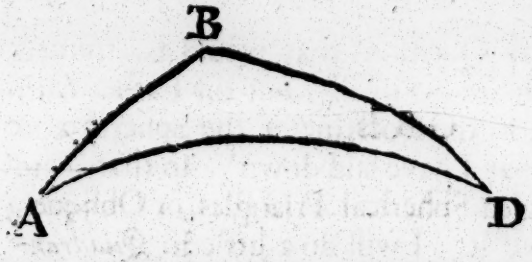
I am the willinger to do Examples of this nature, becauſe 'tis ſo uſeful at Sea for finding the Variation of the Compaſs, as I ſhall ſhew at large, when I come to the Application of it to Aſtronomy, where I purpoſe to vary this Caſe.

CASE 12.

The three Angles of an Oblique Spherical Triangle given, to find the Sides.

ADmit in the Triangle (here following) there be given,

	d.	m.	
The Angle at A	36	35	
The Angle at B	118	01	And let the ſide B D be required.
The Angle at D	42	27	



If we convert the Angles into Sides, and the Sides into Angles, we may do this as we did the laſt, obſerving the ſame Rule for the ſolution of them; onely taking the Complement of the greateſt Angle to 180 degrees, inſtead of the Angle it ſelf.

Take half the difference of the two Angles, between which is the ſide required.

And adde that to half the Angle oppoſite to that ſide, and ſubſtract it from it, noting the ſum and remainder.

Then

Then this is the RULE.

To the Complements Arithmetical of the Sines of them two Angles joyning to the Side required, if you adde the Sines of the aforesaid sum and remainder, the half of that sum or total is the Sine of half the Side required.

Example.

			d.	m.
The Angle at B, its Complement to 180 deg. is			61	59
The Angle at D is			42	27
The difference between the Angles is			19	32
	The half difference is		9	46
	Half the Angle at A is		18	17 ½
		Sum	28	63 ½
		Remainder	08	31

s. B	61 *deg.* 59′	*co. ar.*		0.05413
s. D	42 *deg.* 27′	*co. ar.*		0.17073
s. The sum	28 *deg.* 03′			9.67243
s. The remainder	08 *deg.* 31′			9.17054
			Sum	19.06783
s. Half DB	20 *deg.* 00′		Half sum	9.53391
Doubled, it's DB	40 *deg.* 00′		required.	

I might have shewed the several Questions that would be framed from one Oblique Triangle, which are 60 in all; but my Father hath pointed to them as he goes along, in the Doctrine of the Sphere, and they all come under these Rules that I have laid down: so that there can be no Case of either right angled Spherical Triangles, or Oblique; but you are fitted readily to resolve it. I will do a little in *Quadrantal Triangles*, and so proceed to the Application of all these: First, in *Astronomy*, and then in Sailing by a *Great Circle*.

CHAP.

CHAP. XXXII.
Of Quadrantal Triangles.

If a Triangle have one or more of its sides 90 degrees or a Quadrant, it's called a Quadrantal Triangle.

Fig. II. AS in the Scheme going the Triangle A R B is a quadrantal Triangle, because the side A R is a Quadrant.

And as in a right angled Triangle there be five things considerable besides the right *Angle*, so in a quadrantal there be five things considerable besides the quadrantal side; and these five things are three of them noted to be Complements, (namely them three) that lie fartheſt from the quadrantal side; the other two things that lie next the quadrantal side are not noted by their Complements; just as it is from a right *Angle* in a right angled Triangle; so it is from a quadrantal side in a quadrantal Triangle, and in every kind so to be accounted.

Then you may note that the *Angle* at A and the *Angle* at R are not parted by the side A R, no more than the side A L and L B is parted by the right *Angle* L, (in that right angled Triangle B L A) but all things to correspond from the quadrantal side in this Triangle, as they do from the right *Angle* in a right angled Triangle: These things premiſed we'll depend upon the Rule or *Axiome*, and proceed to Example.

The Sine of the middle part with Radius, is equal to the Tangents of the adjacent Extremes, or to the Sines Complement of the Oppoſite Extremes.

CASE I.

The two Angles next the Quadrantal Side given, to find either of the other two Sides.

In the quadrantal Triangle A R B (the quadrantal side is A R)

Let there be given the *Angle* at A the Suns Poſition between the Pole and the Zenith at his riſing (the Complement of L A B to 90 *deg.*) } 36 *deg.* 26'

The

The *Angle* at R (namely A R B) the Suns *Azimuth* of riſing = to A L 61 *deg.* 38′, and let B A the Suns Declination Complement be required.

I conſider here (that if A R do not part them) then 'tis an adjacent Extreme, and A is the middle part.

s. A + *Radius*, is = to *t.* R + *t. co.* A B.

t. R	61 *deg.* 38′ *co. ar.*	9.93235
s. A	36 *deg.* 26′	9.77370
t. co. A B	72 *deg.* 13′	9.50605

And thus the Compliment of the Suns Declination is the ſame that it was in the right angled Triangle A L B.

Note, that the parts of this quadrantal Triangle are the Complements of the right angled Triangle that I wrought thoſe Caſes of a right angled Triangle by, except A B (which is a ſide of that and of this too) and A R B, which is = to A L in that; for R B is the Complement of B L to 90 *deg.* and A B R is the Complement of A B L to 180 *deg.* and R A B is the Complement of L A B to 90 *deg.* and though A B R be above an *Angle* of 90 *deg.* 'tis but uſing its Complement to 180 *deg.* (which is A B L as though it were the real *Angle* it ſelf: and the reaſon of it is, becauſe an *Angle* leſs than 90 *deg.* hath the ſame Sine or Tangent that an *Angle* as much greater (as we have ſhewed before) ſo that in all reſpects we may work from the quadrantal ſide here R A as we did from the right *Angle* there.

I intend onely to ſhew one Example in an Oppoſite Extreme and leave the other 14 Caſes of a Quadrantal Triangle to your own practice.

CASE 2.

A Side and the Angle oppoſite to the Quadrantal Side being given, to find one of the other Angles.

In the Triangle A B R let there be given

The Suns Complement of Declination A B 72 *deg.* 13′

The

The hour of the Suns rising from 12 of the Clock at Noon A B R 112 *deg.* 28′ (its Complement to 180 *deg.* is 67 *deg.* 32′)
And let the Suns *Azimuth* of rising A R B be required.

Data. { A B 72 *deg.* 13′ ; A B R 112 *deg.* 28′ ; A R B is required. } *s.* R + *Rad.* is = to *s.* B A + *s.* B

s. B A	72 *deg.* 13′		9.97873
s. A B R	67 *deg.* 32′	(Its Complement to 180 *deg.*)	9.96571
s. A R B	61 *deg.* 38′		9.94444

And thus the Suns *Azimuth* of rising is found with the same ease as in the right angled Triangle A L B.

So then the Suns *Amplitude* of rising is also the Complement of this *Angle* found to 90 *deg.* namely ♈ R A 38 *deg.* 22′; because I would be brief I leave these things to your own practice, and come next to the application of this Doctrine of Triangles both in *Astronomy* and *Sailing* by the *Arch* of a great Circle.

CHAP. XXXIII.

Oblique Spherical Triangles applied to some Questions in Astronomy.

Fig. III. TO abreviate the applicatory part of Oblique Spherical Triangles, I used this real Triangle of the Sphear A R G, wherein (as I then noted)

A R represents the Complement of the Latitude.
A the Hour from Noon.
C the *Angle* of the Suns Position.
A G the Complement of the Suns Declination.
G R the Complement of the Suns Height.
G R A the Suns *Azimuth* from the North.

QUEST.

QUEST. 1.

Admit I be in the Latitude of 50 deg. 00 min. *North, and at* 9 ho. 10 min. 12 sec. *in the Forenoon I would know the Suns* Azimuth *from the East-point of the Horizon, allowing the Suns Declination to be Northerly* 17 deg. 47 min.

I Substract the hour *9 ho.* 10′ 12″ from 12 hours, and so I have 2 *ho.* 49′ 48″; which converted into Degrees and Minutes of a Degree, is the *Angle* at A 42 *deg.* 27′; and I have the Complement of the Suns Declination given A G 72 *deg.* 13′, and the Complement of the Latitude A R 40 *deg.* 00′.

To find the *Angle* G R A the Suns *Azimuth* From the North, and consequently from the East or West.

This very Question is resolved in the third Case of Oblique Triangles, *Example* the second, look there and you may be satisfied how to attain your desire:

It is G R A	118 *deg.* 00′
From which if you substract A R C	90 *deg.* 00′
The remainder is the Suns *Azimuth* from the East Southerly G R C which was required.	28 *deg.* 00′

QUEST. 2.

Admit the Suns Declination be Northerly 17 deg. 47 min. *the Latitude I am in be* 50 deg. 00 min. *Northerly, and the hour from Noon be* 42 deg. 27 min. *I demand the Angle of the Suns Position with the Zenith and the North Pole.*

	d.	*m.*
IN this Question we have given the *Angle* at A	42	27
The side A R, which is the Comp. of the Latitude	40	00
The Suns Declination Complement G A	72	13

And the *Angle* required is G the *Angle* of the Suns Position.

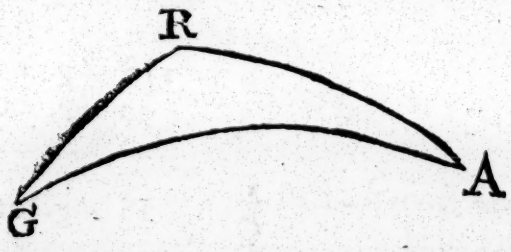
Here is two ſides, and a contained *Angle* given, to find an *Angle*: and you have the queſtion reſolved in the firſt *Example* in the third Caſe: It is 36 *deg.* 35 *min.*

QUEST. 3.

Let the Complement of the Suns Declination be 72 deg. 13 min. *Northerly, the Latitude be* 50 deg. 00 min. *Northerly, the hour from Noon be* 42 deg. 27 min. *I demand the Suns height.*

	d.	*m.*
Here is given the *Angle* at A	42	27
The ſide G A	72	13
The Complement of the Latitude, which is A R	40	00

And R G the Complement of the Suns height is required.



That is two ſides, and the contained *Angle* given, to find the third ſide; and you will ſee the ſame Queſtion wrought in the fourth Caſe; the Complement of the Suns height G R is 46 *deg.* 43′ the Suns height then is the Complement of that to 90 *deg.* in the Scheme F G 43 *deg.* 17′.

After this manner one may make Tables of the Suns height for every Hour and Minute of the day; for the making of Dyals and Quadrants.

QUEST.

QUEST. 4.

Admit I were in the Latitude of 50 deg. 00 min. *Northerly, and obſerved the Suns height to be* 43 deg. 17 min. *at the ſame time (if his Azimuth from the North be* 118 deg.) *I demand his Declination.*

Subſtract 50 *deg.* 00′ from 90 *deg.* and ſo I have A R the Complement of the Latitude	40 *deg.* 00′
The *Angle* at R, is the Suns *Azimuth* from the North	118 *deg.* 00′
And if you ſubſtract the Suns *Altitude* 43 *deg.* 17′ from 90 *deg.* you have G R	46 *deg.* 43′

And G A, the Complement of the Suns Declination is required.

You may ſee this Queſtion reſolved in the ſecond *Example* of the third Caſe, and the Complement of the Suns Declination is 72 *deg.* 13′ G A, which ſubſtracted from A X in the Scheme, leaves the Suns Declination X G 17 *deg.* 47′.

QUEST. 5.

Admit I am in the Latitude of 50 deg. 00 min. *North Latitude, and the Suns Declination Northerly be* 17 deg. 47 min. *I demand the hour of the day, (provided the Complement of the Suns Altitude be* 46 deg. 43 min.)

	d.	*m.*
The Complement of the Latitude is A R	40	00
The Complement of the Suns Declination is A G	72	13
The Complement of the Suns Altitude is G R	46	43

The hour from Noon or *Angle* at A is required.

This Queſtion is reſolved under the Eleventh Caſe, and it is A 42 *deg.* 27′: after this manner you may find the hour of the day

The hour of the Suns rising from 12 of the Clock at Noon A B R 112 *deg.* 28′ (its Complement to 180 *deg.* is 67 *deg.* 32′)
And let the Suns *Azimuth* of rising A R B be required.

Data. { A B 72 *deg.* 13′ ; A B R 112 *deg.* 28′ ; A R B is required. } *s.* R + *Rad.* is = to *s.* B A + *s.* B

s. B A	72 *deg.* 13′	9.97873
s. A B R	67 *deg.* 32′ (Its Complement to 180 *deg.*)	9.96571
s. A R B	61 *deg.* 38′	9.94444

And thus the Suns *Azimuth* of rising is found with the same ease as in the right angled Triangle A L B.

So then the Suns *Amplitude* of rising is also the Complement of this *Angle* found to 90 *deg.* namely ♈ R A 38 *deg.* 22′; because I would be brief I leave these things to your own practice, and come next to the application of this Doctrine of Triangles both in *Astronomy* and *Sailing* by the *Arch* of a great Circle.

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A the Hour from Noon.
C the *Angle* of the Suns Position.
A G the Complement of the Suns Declination.
G R the Complement of the Suns Height.
G R A the Suns *Azimuth* from the North.

QUEST.

QUEST. 1.

Admit I be in the Latitude of 50 deg. 00 min. *North, and at* 9 ho. 10 min. 12 ſec. *in the Forenoon I would know the Suns* Azimuth *from the Eaſt-point of the Horizon, allowing the Suns Declination to be Northerly* 17 deg. 47 min.

I Subſtract the hour 9 *ho.* 10′ 12″ from 12 hours, and ſo I have 2 *ho.* 49′ 48″; which converted into Degrees and Minutes of a Degree, is the *Angle* at A 42 *deg.* 27′; and I have the Complement of the Suns Declination given A G 72 *deg.* 13′, and the Complement of the Latitude A R 40 *deg.* 00′.

To find the *Angle* G R A the Suns *Azimuth*
From the North, and conſequently from the Eaſt or Weſt.

This very Queſtion is reſolved in the third Caſe of Oblique Triangles, *Example* the ſecond, look there and you may be ſatisfied how to attain your deſire:

It is G R A	118 *deg.* 00′
From which if you ſubſtract A R C	90 *deg.* 00′
The remainder is the Suns *Azimuth* from the Eaſt Southerly G R C which was required.	28 *deg.* 00′

QUEST. 2.

Admit the Suns Declination be Northerly 17 deg. 47 min. *the Latitude I am in be* 50 deg. 00 min. *Northerly, and the hour from Noon be* 42 deg. 27 min. *I demand the Angle of the Suns Poſition with the Zenith and the North Pole.*

	d.	*m.*
IN this Queſtion we have given the *Angle* at A	42	27
The ſide A R, which is the Comp. of the Latitude	40	00
The Suns Declination Complement G A	72	13

And the *Angle* required is G the *Angle* of the Suns Poſition.

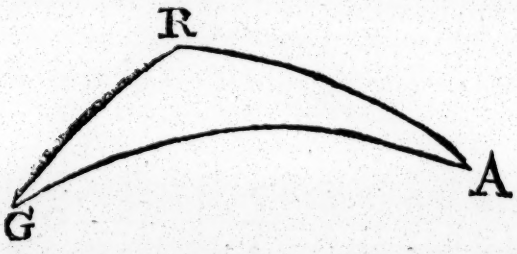
Here is two ſides, and a contained *Angle* given, to find an *Angle*: and you have the queſtion reſolved in the firſt *Example* in the third Caſe; It is 36 *deg.* 35 *min.*

QUEST. 3.

Let the Complement of the Suns Declination be 72 deg. 13 min. *Northerly, the Latitude be* 50 deg. 00 min. *Northerly, the hour from Noon be* 42 deg. 27 min. *I demand the Suns height.*

	d.	*m.*
Here is given the *Angle* at A	42	27
The ſide G A	72	13
The Complement of the Latitude, which is A R	40	00

And R G the Complement of the Suns height is required.



That is two ſides, and the contained *Angle* given, to find the third ſide; and you will ſee the ſame Queſtion wrought in the fourth Caſe; the Complement of the Suns height G R is 46 *deg.* 43′ the Suns height then is the Complement of that to 90 *deg.* in the Scheme F G 43 *deg.* 17′.

After this manner one may make Tables of the Suns height for every Hour and Minute of the day; for the making of Dyals and Quadrants.

QUEST.

QUEST. 4.

Admit I were in the Latitude of 50 deg. 00 min. *Northerly, and obſerved the Suns height to be* 43 deg. 17 min. *at the ſame time (if his Azimuth from the North be* 118 deg.) *I demand his Declination.*

Subſtract 50 *deg.* 00′ from 90 *deg.* and ſo I have A R the Complement of the Latitude	40 *deg.* 00′
The *Angle* at R, is the Suns *Azimuth* from the North	118 *deg.* 00′
And if you ſubſtract the Suns *Altitude* 43 *deg.* 17′ from 90 *deg.* you have G R	46 *deg.* 43′

And G A, the Complement of the Suns Declination is required.

You may ſee this Queſtion reſolved in the ſecond *Example* of the third Caſe, and the Complement of the Suns Declination is 72 *deg.* 13′ G A, which ſubſtracted from A X in the Scheme, leaves the Suns Declination X G 17 *deg.* 47′.

QUEST. 5.

Admit I am in the Latitude of 50 deg. 00 min. *North Latitude, and the Suns Declination Northerly be* 17 deg. 47 min. *I demand the hour of the day, (provided the Complement of the Suns Altitude be* 46 deg. 43 min.)

	d.	*m.*
The Complement of the Latitude is A R	40	00
The Complement of the Suns Declination is A G	72	13
The Complement of the Suns Altitude is G R	46	43

The hour from Noon or *Angle* at A is required.

This Queſtion is reſolved under the Eleventh Caſe, and it is A 42 *deg.* 27′: after this manner you may find the hour of the day

for every height of the Sun, it is here converted into time 2 *ho.* 49′ 48″ before 12 of the Clock, which is 9 of the Clock 10′ 12″. In the ſame caſe you may with the ſame things given find the Suns *Azimuth* at that time. And in the ſame manner, with the ſame things, you may find the Suns *Angle* of Poſition. I will do an Example of it here, to find the Suns *Azimuth*, becauſe 'tis of great uſe for the finding the *Variation of the Compaſs*.

QUEST. 6.

Admit the Suns Almicanther, or height above the Horizon, be 43 deg. 17 min. *its Complement* 46 deg. 43 min. *the Complement of the Suns Declination be* 72 deg. 13 min. *the Latitude that I am in be* 50 deg. 00 min. *I demand the Suns Azimuth from the North.*

		d.	*m.*
Data.	G R the Complement of the Suns height	46	43
	G A the Complement of the Suns Declination	72	13
	A R the Complement of the Latitude	40	00

I demand the Suns *Azimuth* from the North R.

The ſide A R is	40 *deg.* 00′
The ſide R G is	46 *deg.* 43′
Their difference is	06 *deg.* 43′
Half their difference is	3 *deg.* 21′ 30″
Half G A is	36 *deg.* 06′ 30″
Adde the. half difference	03 *deg.* 21′ 30″
The Sum is	39 *deg.* 28′ 00″
The remainder is	32 *deg.* 45′ 00″

s. R A

	d.	*m.*	
s. R A	40	00 *co. ar.*	0.19193
s. G R	46	43 *co. ar.*	0.13788
s. the Sum	39	28	9.80320
s. the Remainder	32	45	9.73317
Half the *Angle* required is half			19.86618
Which is	59 *deg.* 00′		9.93309

So that this 59 *deg.* 00′ doubled, is 118 *deg.* 00′ the *Angle* at R required.

Thus the Suns *Azimuth* may be found at any time of the day by obſerving his height, which is uſed very much going to the *Eaſt-Indies*, and ſome times to other parts, as at the *Weſtern Iſlands*, *Greenland*, &c.

If in the Queſtion preceding, you would know the Suns *Azimuth* from the Eaſt, 'tis but ſubſtracting 90 *deg.* from the *Azimuth* found, and you have it; becauſe it's from the North ſo much above 8 points or 90 *deg.* it's here Eaſt 28 *deg.* Southerly.

But if the *Angle* at R had not been ſo much as 90 *deg.* then you muſt have ſubſtracted the *Angle* found from 90 *deg.* and it would have given the Suns *Azimuth* from the Eaſt.

If you would know the Suns *Azimuth* from the South (in the Queſtion) you muſt have ſubſtracted the *Angle* found from 180 *deg.* 00′ and it would have given your deſire: But theſe things I leave to your own practice.

There be ſeveral things that you may find in this Triangle of great uſe (as you may ſee by what is ſaid already) in *Navigation*, which your practice will make you perfect in, and therefore to that I refer you.

QUEST.

QUEST 7.

Admit I be in North Latitude 50 deg. 00 min. *and at* 2 ho. 49 min. 48 sec. *after* 12 *of the Clock in the Afternoon, I would know the Suns height above the Horizon, the Suns Declination being Southerly* 9 deg. 10 min.

Fig. IV. THis Queſtion will be preſented in Scheme IV. wherein there is given, in the Triangle G R A,

The ſide A R	40 *deg.* 00′
The hour after 12 a clock, converted into degrees and minutes, G A R	42 *deg.* 27′
The Complement of the Suns Declination (or his diſtance from the North Pole) G R	99 *deg.* 10′

And let the Complement of the Suns height be demanded, G R.

I conſider here we have two ſides, and the contained Angle given, to find the third ſide.

I let fall the Perpendicular from R, which is in the Triangle, as R I; and ſo in the right angled Triangle R I A, I have given,

R A 40 *deg.* 00′
R A G 42 *deg.* 27′ } *s. co.* A + *Radius*, is = to *t. co.* A R + *t.* A I
To find A I.

Rad.			10.
co. s. R A I	47 *deg.*	33′	9.86797
t. R A	40 *deg.*	00′	9.92381
t. A I	31 *deg.*	46′	19.79178

This A I 31 *deg.* 46′ (being the Suns diſtance from the North Pole) Subſtracted from A G 99 *deg.* 10′ there remains 67 *deg.* 24′ for I G.

And

And now we have I G respondent to I A; and the thing required G R, is respondent to R A, the Latitude given: so that

As *s. co.* A I	58 *deg.* 14′	*co. ar.*	0.07047
Is to *s. co.* I G	42 *deg.* 36′		9.58466
So is *s. co.* A R	50 *deg.* 00′		9.88425
To *s. co.* G R	20 *deg.* 15′ the Suns height		9.53938

The Complement whereof 69 *deg.* 45′ is the side G R required.

In this manner you may find the Suns height for every hour or minute of the day: let the Suns Declination be either Northerly or Southerly; Or if the Latitude were Southerly, from the South Pole in such a Triangle as this is, you may find any thing that you do in a Northern Latitude. I need not do Examples of every one, because it will take up too much room.

QUEST. 7.

The Latitude and Longitude of any Star given, to find his Right Ascension and Declination.

Admit Persius's *right Shoulder be* Longitude 25 deg. 18′ *of* ♉, *and have North* Latitude 34 deg. 30′; *I demand his* Right Ascension *and* Declination.

Fig V. NOte, that the Latitude of a Star is the distance of that Star from the Ecliptick, either Northerly or Southerly, in a Circle that cuts the Ecliptick from the Poles thereof: as in the Figure * L is the Latitude of the *, or its distance in the Circle B * L which comes from B the Pole of the Ecliptick.

The Longitude of a Star is his place in the Ecliptick, or his distance in the Ecliptick, From ♈ counting the Signes successively, as O ♈.

Right Ascension of the Sun or of a Star, is alike, namely that Meridian-distance from ♈ that comes with the *, and cuts the Equinoctial. Now where it cuts the Equinoctial, there is the Stars Right Ascension, as here A * cuts the Equinoctial in I: and therefore I ♈ is the Stars Right Ascension = to the Angle I A ♈.

Here

Here then (in the Triangle * B A) we have given,

A B the distance of the North Pole from the Pole of the Ecliptick	23 *deg.* 30′
* B the Complement of the Stars Latitude	55 *deg.* 30′
* B A the Stars Longitude from *Cancer*	34 *deg.* 42′

To find first the Complement of the Stars Declination A *, we will let fall the Perpendicular A E; and so in the right angled Triangle B E A there is given,

s. co. B + *Radius*, is = to *t. co.* B A + *t.* B E.

		d.	*m.*		*d.*	*m.*	
Data.	A B	23	30	*t.* B A	23	30	9.63830
	* B A	34	42	*s. co.* A B *	34	42	9.91494
	To find B E			*t.* B E	19	40	9.55324

This B E subſtracted from B *	55	30
Leaves E *	35	50

Say then again,

	d.	*m.*		
As *s. co.* B E	19	40	*co. ar.*	0.02610
Is to *s. co.* * E	35	50		9.90887
So is *s. co.* B A	23	30		9.96239
To *s. co.* A *	37	52		9.89737
From A * O I	90	00		
Subſtract A * ſo found	37	52		
The remainder is * I	52	08	The Stars Declination required.	

Next, for the Angle * A B.

	d.	*m.*		
As *s.* * A	37	52	*co. ar.*	0.21195
To *s.* * B A	34	42		9.75532
So *s.* * B	55	30		9.91599
To *s.* * A B	49	51		9.88326

This

This 49 *deg.* 51′ is the Complement of * A B to 180 *deg.* So that the *Angle* here looked for, is the * Right Ascension 130 *deg.* 09′ from Midnight.

From which if you substract B A ♈ 090 *deg.* 00′

The remainder is * A ♈ 40 *deg.* 09′
= to which, is I ♈, the Right Ascension of the * required.

And the reason is plain: for A ♈ is 90 *deg.* and A I is 90 *deg.* therefore I ♈ is the measure of the *Angle* ♈ A * I, or equal to it.

QUEST. 8.

Admit the Right Ascension of the same Star, namely Perseus's *right Shoulder, were* 40 deg. 09 min. *and the Declination of it were* 52 deg. 8 min. *I demand the Latitude and Longitude of the same Star.*

THis would be the converse of the former Question: for the same thing is required here, that was given there.

For in the Triangle * A B, I have given,

* A	40 *deg.* 09′	its Right Ascension.
Which added to ♈ A B	90 *deg.* 00′	
Gives the Stars Right Ascension from the North, * A B	130 *deg.* 09′	

	d.	*m.*
And the Declination of the Star is I *	52	08
Whose Complement to 90 *deg.* I A, is * A	37	52
And A B is as before the Pole of the Ecliptick's distance from the Poles Elevation	23	30

	d.	*m.*
So that thus I have given (I say) * A	37	52
The *Angle* at A, namely * A B	130	09
And the side A B	23	30

That is, two sides and a contained Angle, to find the third side, and the Angle A B *; that is, the Latitude and Longitude of that Star.

I have thus delineated the Queſtion, and need not do an Example of it, but leave it to your own practice, for brevity ſake; and becauſe I have ſhewed ſeveral Examples of this nature in the Doctrinal part of *Spherical Triangles.*

QUEST. 9.

Admit that I be in the Latitude of 51 deg. 30 min. *and the* 11th *day of* Auguſt, 1684. *the Sun hath North Declination* 11 deg. 54 min. *Now* Perſius's *right Shoulder hath Right Aſcenſion* 40 deg. 09 min. *and I obſerve him before he comes to the Meridian, and find his Altitude* 30 deg. 00 min. *I demand his time of coming to the Meridian, and the true time of Night.*

Note, *That the Declination of* Perſius's *right Shoulder is Northerly* 52 deg. 09′.

Fig. VI. FOr the reſolving this Queſtion, 'twill be neceſſary in the firſt place to find the *Suns Right Aſcenſion:* To attain which,

In the Triangle ♈ R ☉, right angled at R.

		d.	*m.*		
Data.	R ♈ ☉ the Suns greateſt Declin.	23	30	*t. co.*	0.36169
	R ☉ the Suns preſent Declination	11	54	*t.*	9.32373
	Required ♈ R = to	29	00	*s.*	9.68542

Here we have found ♈ R to be 29 *deg.* 00′
Which ſubſtracted from 180 *deg.* 00′

It gives the *Suns Right Aſcenſion* 151 *deg.* 00′

If you ask why ♈ R is not the *Suns Right Aſcenſion*, I would have you conſider the time of year; the Sun is in *Leo*, and that muſt be a great way from ♈: ſo that the diſtance that we found was ♎ R 29 *deg.* 00′, the Suns diſtance from ♎, which is = to ♈ R.

Next,

Next, for the Angle * B D.

We have given in that Triangle A B D, the ſide A B, which is the Stars Declination Complement	37 *deg.* 51′
A D the Complement of the Stars Altitude	60 *deg.* 00′
The Complement of the Latitude B D	38 *deg.* 30′

And A B D, the Angle of the Stars, being ſhort of the Meridian of South, is required; that is, three ſides given to find an Angle.

	d.	*m.*		*d.*	*m.*
The ſide A B is	37	51	Half A D is	30	00
The ſide B D is	38	30	Half difference added	00	19
Difference	00	39	Sum	30	19
Half difference	00	19	Remainder	29	41

s. B A	37 *deg.* 51′	*co. ar.*	0.21211
s. B D	38 *deg.* 30′	*co. ar.*	0.20585
s. Sum	30 *deg.* 19′		9.70310
s. Remainder	29 *deg.* 41′		9.69478
			19.81584
A B D its half	54 *deg.* 00′		9.90732
	2		
Doubled is	108 *deg.* 00′		

The Angle required A B D, (the time after this obſervation, before this Star will come upon the Meridian) which is 7 *ho.* 12′.

But for the hour of this Stars coming upon the Meridian,

	d.	*m.*
I adde to the Right Aſcenſion of the Star	40	09
Twenty four hours or	360	00
And from that ſum, being	400	09
Subſtract the Suns Right Aſcenſion	151	00
And the remainder is	249	09
Which converted into time, is	16 *h.* 36′	36″

So long after 12 of the clock at Noon it will be, before that Star will be upon the Meridian, which is at 4 a clock 36′ 36″ in the Morning.

And lastly, for to know the true time of Night that I observed the Star.

Substract the time between my observing the Star, and his coming to the Meridian, which was	7 *ho.* 12′
From the time after Noon that the Star will be upon the Meridian	16 *ho.* 36′ 36″
And the remainder is the true time I observed at	09 *ho.* 24′ 36″

And thus you may find the hour of the Night at any time, by taking the height of a known Star (provided you know his *Place*, *Right Ascension*, and *Declination*; and the *Suns Declination* or *Place* in the *Ecliptick*) whereby you may find his Right Ascension (as hath been shewed) by that and his greatest Declination.

But indeed it's necessary to have Tables of the *Suns Right Ascension* by one, as well as of the Stars; and therefore upon second thoughts I have here placed them, though it was not my intent at first.

Fig. I.

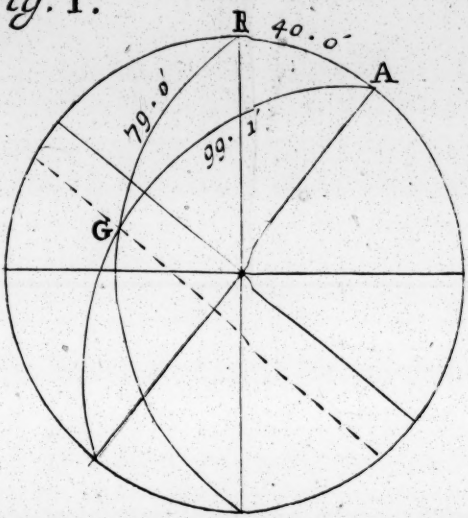


Fig. II.

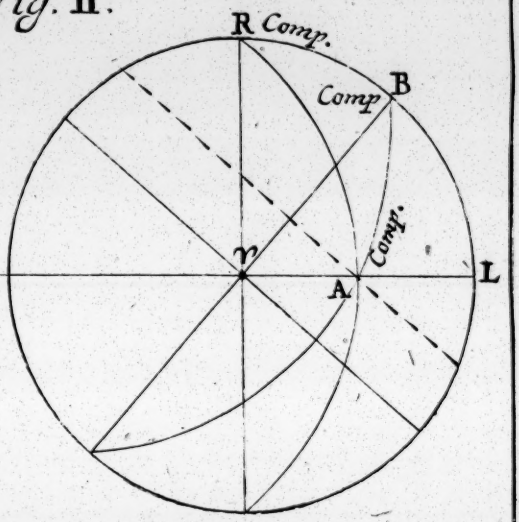


Fig. III.

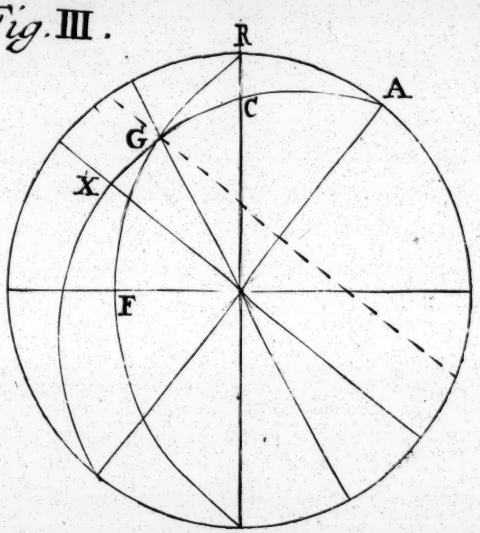


Fig. IV.

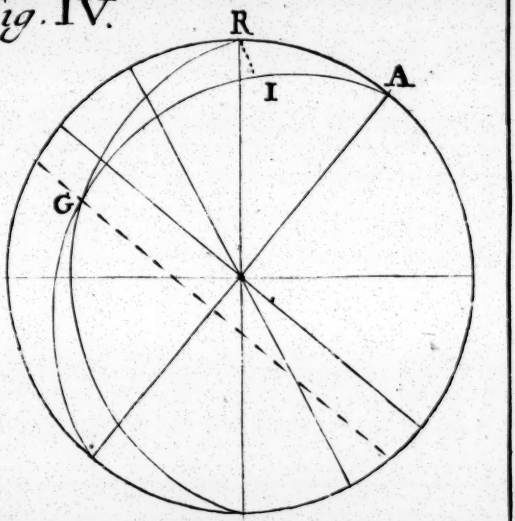


Fig. V.

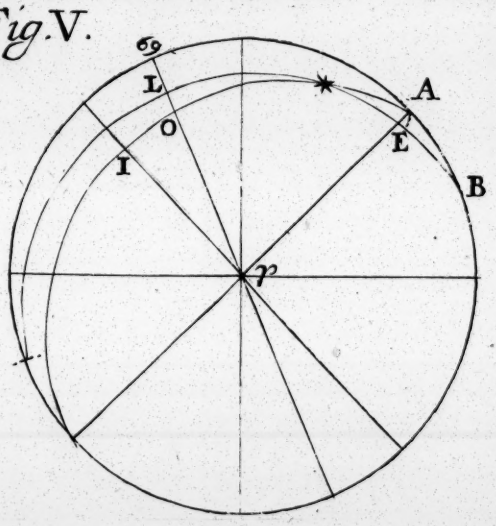
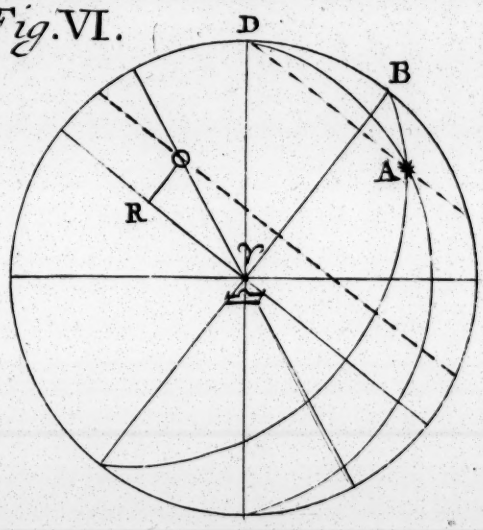


Fig. VI.



Against Page 316.

A Table of the Suns Right Ascension, *converted into Time: which may serve for all the Years of Declination (for ordinary uses.)*

Days.	January. ☉ Right Ascension.		February. ☉ Right Ascension.		March. ☉ Right Ascension.		April. ☉ Right Ascension.		May. ☉ Right Ascension.		June. ☉ Right Ascension.	
	ho.	*m.*	*ho.*	*m.*	*ho.*	*m.*	*ho.*	*m.*	*ho.*	*m.*	*ho.*	*m*
1	19	32	21	40	23	27	01	20	03	13	05	19
2	19	37	21	44	23	31	01	24	03	17	05	23
3	19	41	21	48	23	35	01	28	03	21	05	27
4	19	45	21	52	23	38	01	32	03	25	05	31
5	19	49	21	56	23	42	01	35	03	29	05	36
6	19	54	22	00	23	45	01	39	03	33	05	40
7	19	58	22	04	23	49	01	44	03	37	05	44
8	20	02	22	08	23	52	01	46	03	41	05	48
9	20	07	22	12	23	56	01	50	03	45	05	52
10	2	11	22	15	00	00	01	53	03	49	05	56
11	20	15	22	20	00	04	01	57	03	53	06	00
12	20	20	22	23	00	07	02	01	03	57	06	04
13	20	24	22	27	00	11	02	05	04	01	06	08
14	20	28	22	31	00	14	02	09	04	05	06	12
15	20	32	22	34	00	18	02	12	04	09	06	16
16	20	36	22	38	00	22	02	16	04	13	06	21
17	20	40	22	42	00	25	02	20	04	17	06	25
18	20	44	22	46	00	29	02	24	04	21	06	29
19	20	50	22	52	00	32	02	28	04	25	06	33
20	20	52	22	53	00	36	02	31	04	29	06	37
21	20	56	22	57	00	40	02	35	04	33	06	41
22	21	01	23	01	00	43	02	39	04	37	06	46
23	21	05	23	04	00	47	02	43	04	41	06	50
24	21	09	23	08	00	51	02	46	04	45	06	54
25	21	13	23	11	00	54	02	50	04	49	06	58
26	21	17	23	15	00	58	02	54	04	53	07	02
27	21	21	23	19	01	02	02	58	04	57	07	06
28	21	25	23	23	01	05	03	02	05	01	07	10
29	21	29	23	27	01	09	03	05	05	05	07	14
30	21	33	*If Leap-year,*		01	13	03	09	05	10	07	18
31	21	36	*this last.*		01	16			05	15		

A Table of the Suns Right Ascension. *converted into Time: which may serve for all the years of Declination (for ordinary uses.)*

Days.	*July.* ☉ Right Ascension.		*August.* ☉ Right Ascension.		*September.* ☉ Right Ascension.		*October.* ☉ Right Ascension.		*Novemb.* ☉ Right Ascension.		*Decemb.* ☉ Right Ascension.	
	ho.	*m.*	*ho.*	*m.*	*ho.*	*m.*	*ho.*	*m.*	*ho.*	*m.*	*ho.*	*m.*
1	07	23	09	25	11	18	13	07	15	07	17	14
2	07	27	09	29	11	23	13	11	15	11	17	19
3	07	31	09	33	11	26	13	14	15	14	17	24
4	07	35	09	37	11	30	13	18	15	18	17	28
5	07	39	09	41	11	33	13	22	15	22	17	33
6	07	43	09	45	11	37	13	26	15	26	17	37
7	07	47	09	49	11	40	13	30	15	30	17	41
8	07	51	09	52	11	44	13	33	15	35	17	46
9	07	55	09	56	11	48	13	37	15	39	17	50
10	07	59	09	59	11	51	13	41	15	44	17	55
11	08	03	10	03	11	55	13	44	15	49	18	00
12	08	07	10	07	11	59	13	48	15	53	18	04
13	08	11	10	10	12	02	13	52	15	57	18	08
14	08	15	10	14	12	05	13	56	16	01	18	13
15	08	19	10	18	12	09	14	00	16	06	18	18
16	08	23	10	22	12	13	14	04	16	10	18	23
17	08	27	10	26	12	16	14	07	16	15	18	28
18	08	31	10	30	12	20	14	11	16	19	18	33
19	08	35	10	33	12	24	14	15	16	23	18	37
20	08	39	10	37	12	27	14	19	16	27	18	41
21	08	43	10	40	12	31	14	23	16	31	18	45
22	08	47	10	43	12	35	14	27	16	36	18	49
23	08	51	10	47	12	39	14	31	16	40	18	53
24	08	54	10	51	12	42	14	35	16	44	18	57
25	08	58	10	54	12	46	14	39	16	48	19	02
26	09	02	10	57	12	49	14	43	16	52	19	07
27	09	06	11	01	12	53	14	47	16	56	19	11
28	09	10	11	04	12	57	14	51	17	01	19	15
29	09	14	11	08	13	00	14	55	17	05	19	19
30	09	18	11	12	13	04	14	59	17	10	19	24
31	09	22	11	15			15	03			19	28

This Table may ſerve for all the years of Declination for to find the time of a Stars coming upon the Meridian to obſerve for Latitude or for ſeveral other things; but in things that required more exactneſs, I wiſh every man to work it as I have ſhewed in two or three *Examples*, where it's found to the ſecond of a Minute of Time, and muſt be ſo for things of that nature that I ſhew it, for there indeed exactneſs is beſt in every thing; but here one years right Aſcention will ſerve for all and be exact enough.

To know the time of any Stars coming upon the Meridian.

I Have made Tables of the *Longitude*, *Latitude*, *Declination* and *right Aſcention* of ſome principal Stars.

Now if you would know the time of any of thoſe Stars coming upon the Meridian for any day; ſubſtract the *right Aſcention* of the Sun for that day from the *right Aſcention* of the *, and the remainder is the hour from Noon (ſtated) that the Star will be upon the Meridian.

But if the *right Aſcention* of the Sun be greater than the *right Aſcention* of the *Star*, then add 24 hours to the *right Aſcention* of the *Star*, and ſubſtract the *right Aſcention* of the Sun from that ſum, and it gives the hours after Noon that the *Star* will be upon the Meridian.

As for Example:

Admit the firſt day of *May* the *Suns right Aſcention* be 3 *ho.* 13′, and the *right Aſcention* of the *Lions Tail* be 11 *ho.* 32′; I ſubſtract the *right Aſcention* of the *Sun* from 11 *ho.* 32′ (the *right Aſcention* of the *Star*) and the remainder is 08 *ho.* 19′; ſo I conclude that it will be ſo long after 12 of the Clock at Noon before that *Star* be upon the Meridian.

But imagine in this ſecond Example:

That upon the firſt of *December* I would know what time the firſt in *Orions Girdle* comes to the Meridian: I look in the Tables and find that *Stars right Aſcention* is 78 *deg.* 46′, or 05 *ho.* 15′, I look for the *right Aſcenſion* of the *Sun* for that day, and find that to be 17 *ho.* 14′; and becauſe I cannot ſubſtract the *Suns right Aſcention* from the *Stars*,

Stars, I add 24 hours to the *Stars right Aſcenſion* 05 *ho.* 15′,

And it makes	29 *ho.* 15′
Now ſubſtract the *Suns right Aſcention* from it	17 *ho* 14′
And the remainder is the hour from Noon of the *Stars* coming to the Meridian	12 *ho.* 01′

That is at one minute paſt Twelve of the clock at night.

When you would be very exact indeed for the time of a *Stars* coming to the Meridian, you may conſider the *Suns* difference of *right Aſcenſion* between one day and another is commonly four Minutes of time; ſo that for every ſix hours later that the *Star* comes upon the Meridian than the *Sun* doth you may reckon one minute of time.

Note. The *Stars* alter their time about one hour in Fifteen days (ſooner) for their coming upon the Meridian, by which you may know their Seaſons at any time, when found for ſome one time. Thus much for *Aſtronomy* in this place.

CHAP. XXXIV.

Problems of Sailing by the Arch of a great Circle.

ALl places in the world that lie North and South one from the other, their diſtance on their bearing (either in Leagues or Miles) is their neareſt diſtance one from the other.

Alſo all places that be under the Equinoctial, their diſtance East and Weſt is their neareſt diſtance.

And the reaſon is, becauſe the Equinoctial is a great Circle of the Sphere; and ſo are all Meridians or North and South Lines; but ſerve no any East or Weſt Lines (except the Equinoctial) but as any Parallel or East and Weſt Line is nearer the Poles, ſo them Circles are leſſer than a great Circle, ſo that if in a Parallel of any Latitude known there be two places in that Parallel diſtant any number of miles conſiderable, the neareſt way from one of them to the other is not East or Weſt, but upon that Arch of a great Circle that leades from one of them to the other. As

As imagine in the Latitude of 50 *deg.* 00′ there be two places distant in their Parallel 180 *deg.* or 6942 miles (for in Miles a Semicircle in that Parallel is no more:) I desire to know the neareſt distance between them.

If you look on the Globe for that Parallel, and imagine two places ſo ſcituated, you will find that a Meridian-line (which is in this caſe the great Circle leading between theſe places) will lead you a far nearer way between them than to go upon a Parallel or Eaſt and Weſt Line. I know in this caſe the Arch of a great Circle cannot be uſed, becauſe it goeth under the Pole where no man can go;) But I make this an Example for the informing the Learner how it comes to paſs, that the direct courſe of bearing that leades from one place to another is not the neareſt way, but upon the Arch of a great Circle that leads between them. We come now to the ſeveral Caſes, and to the reſolving of ſeveral Queſtions deduced from thoſe Caſes.

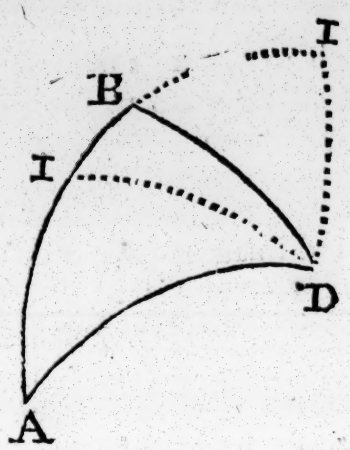
CASE I.

The Latitude of two places being given, and the difference of Longitude between them, to find the neareſt diſtance between them; and the direct Poſition of the firſt place to the ſecond, and of the ſecond place to the firſt.

Queſt. 1. *Admit there be a place in North Latitude* 40 deg. 00′, *another in the Latitude of* 50 deg. 00′ *North Latitude (but to the Eaſtward) and let the difference of Longitude between them be* 23 deg. 30′, *I demand their neareſt diſtance in the Arch of a great Circle, the direct Poſition of the firſt place from the ſecond, and of the ſecond place from the firſt.*

In the Triangle A B D
Let A B be the Complement of 40 *deg.* 00′ namely 50 *deg.* 00′
Let B D be the Complement of 50 *deg.* 00′ namely 40 *deg.* 00′

Let the *Angle* at B be 23 *deg.* 30′ the difference of Longitude between them, (then doth B repreſent the North-Pole) and A D an Arch of a great Circle that leads between them; A is the *Angle* of



direct Position from the first to the second, and D the direct Position from the Easter-moſt to the Weſtermoſt. Firſt then, to find the ſide A D.

We have two ſides and a contained Angle given, to find the third ſide. If we let fall the Perpendicular D I, we have (in the Triangle B I D, right angled at I)

Data. { B D 40 *deg.* 00′ / B 23 *deg.* 30′ } *s. co.* B + *Radius*, is = to *t. co.* B D + *t.* B I
To find B I

D B *t. co.*	40 *deg.* 00′	*co. ar.*	9.92381
B *s. co.*	23 *deg.* 30′		9.96239
B I *t.*	37 *deg.* 35′		9.88620

Which ſubſtracted from B A 50 *deg.* 00′
Leaves I A 12 *deg.* 25′

Now for A D.

As *s. co.* B I	37 *deg.* 37′	*co. ar.*	0.101213
Is to *s. co.* I A	12 *deg.* 25′		9.989721
So is *s. co.* B D	40 *deg.* 00′		9.884254
To *s. co.* D A	18 *deg.* 11′		9.975188

Thus you ſee the diſtance between theſe two places in the Arch of a great Circle, is but 18 *deg.* 11′; which converted into leagues, at 20 leagues to a degree, is 363 leagues 2 miles, or 1091 miles.

Next, to find the Angle at D.

'Tis certain, the Angle at D is above 90 degrees, and therefore we ſhall find his Complement to 180 degrees, thus, by the firſt Caſe of *Oblique Triangles.*

As

	d.	*m.*			*d.*	*m.*
As *s.* BA	18	11	0.50576			
To *s.* B	23	30	9.60069	From	180	00
So *s.* BA	50	00	9.88425	Substract	78	12
To *s.* D	78	12	9.99070	The rema. is ADB	101	48

This 78 *deg.* 12′ is the Angle of direct position of the Eastermost Ship from the Westermost; namely, South 78 *deg.* 12′ Westerly, or West 11 *deg.* 48′ Southerly, which is West by South 37 *deg.* Southerly.

Lastly, for the Angle at A.

	d.	*m.*		
As AD *s.*	18	11	0.50576	Thus the Angle of direct position from the Westermost place to the Eastermost, is 67 *d.* 09′ that is, North 67 *d.* 09′ Easterly.
To B *s.*	23	30	9.60069	
So BD *s.*	40	00	9.80806	
To A *s.*	67	09	9.96451	

The like is to be understood of any other Question of this nature.

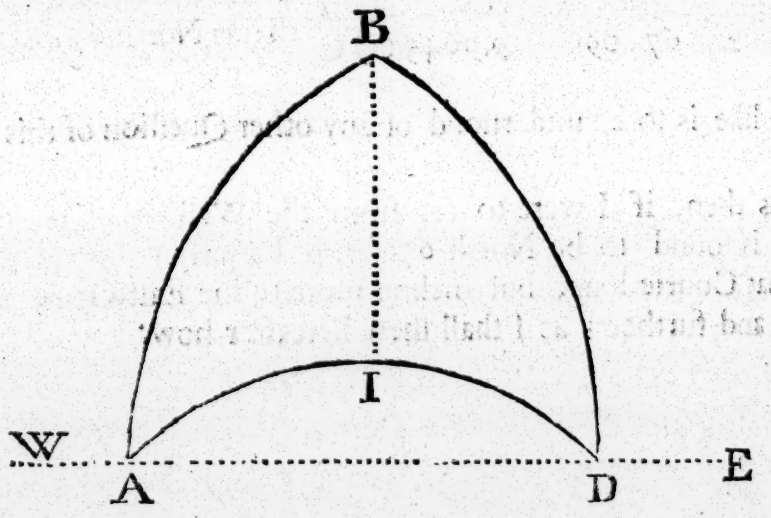
Thus then, if I were to set from the Westermost place, my first Course is found to be North 67 *deg.* 9′ Easterly; but you must not hold that Course long, but incline more to the Eastwards, as you sail further and further; as I shall shew hereafter how.

CASE 2.

Two places being in one Latitude, or Parallel, and their neareſt diſtance being alſo given; to find the difference of Longitude between them, and the direct Poſition of the one place from the other.

Queſt. 2. *Admit there be two places in the Latitude of* 50 deg. 00′ *diſtant in the Arch of a great Circle (which is their neareſt diſtance)* 1800 *miles; I demand the difference of Longitude between them, and the Angles of direct Poſition from the firſt place to the ſecond, or from the ſecond place to the firſt: alſo the Northermoſt Latitude you will ſail to, to follow the Arch of a great Circle.*

In the Triangle A B D, imagine B to be the North Pole.



	d.	*m.*
LEt D B repreſent the Complement of the Eaſtermoſt places, Latitude	40	00
Let A B be the Complement of the Weſtermoſt places, Latitude	40	00
Let A D be the neareſt diſtance of thoſe places in the Arch of a great Circle 1800 miles, or	30	00

And let it be required to find the Angle at A or D, their direct Poſition;

ſition; and the Angle at B; the difference of Longitude between them; alſo B I, the Complement of the Northermoſt Latitude in that Arch.

The reaſon I make the neareſt diſtance of the places to be 30 *deg.* 00′ is, for that in a great Circle of the Earth 60 miles is a degree, concluded upon by all ingenious men that have endeavoured to find the quantity of a degree upon the Earth.

For the reſolving this Queſtion, Let fall the Perpendicular I B, and it divides the Triangle A B D into two right angled Triangles, namely B I D, and B I A; and in each of theſe the correſpondent things are equal, becauſe B D and B A are equal: ſo that if we find the Angle at D in the Triangle B I D, it's = to the Angle at A; and if you find the Angle I B D, it's half the difference of Longitude A B D, or = to A B I.

Firſt, for the Angle at D.

Data. { D B 40 *deg.* 00′ / D I the half of D A 15 *deg.* 00′ / Required D, the Angle of Poſition } *s. co.* D + *Radius* is = to *t. co.* D B + *t.* D I.

	d.	*m.*	
D B *t. co.*	40	00	10.07618
D I *t.*	15	00	9.42805
D *s. co.*	71	23	9.50423

Thus then the firſt Courſe the Eaſtermoſt Ship ſhould ſteer to come the neareſt way to the Weſtermoſt Port, is North 71 *deg.* 23′ Weſterly; that is, Weſt and by North 7 *deg.* 22′ Northerly.

And becauſe the places be both in one Parallel, therefore the Weſtermoſt Ship muſt ſteer Eaſt by North 7 *deg.* 22′ Northerly, at her firſt ſetting from the Weſtermoſt Port, to go the neareſt way to the Eaſtermoſt. But, as I have intimated before, theſe Courſes will alter to keep to a great Circle, and therefore care muſt be taken accordingly, as I ſhall ſhew hereafter.

Next, for the difference of Longitude; the half of which is I B D.

Data. { D B / D I / Required D B I } *s.* I D + *Radius*, is = to *s.* D B + *s.* D B I.

s. D

		d.	*m.*		
s.	DB	40	00	*co. ar.*	0.19193
s.	DI	15	00		9.41299
s.	DBI	23	45		9.60492

And this DBI being doubled, is the difference of Longitude required DBA 47 *deg.* 30′ } 23 *deg.* 45′ × 2 = 47 *deg.* 30′

Lastly, for BI, *the Complement of the Northermost Latitude.*

Data. { DB 40 *d.* 00′ ; DI 15 *d.* 00′ ; Required IB } *s.co.* DB + *Radius*, is = to *s.co.* ID + *s.co.* IB

		d.	*m.*		
s. co.	DI	15	00	*co. ar.*	0.01505
s. co.	DB	40	00		9.88425
s. co.	BI	37	31		9 89930

This 37 *deg.* 31′ is the Complement of the Northermost Latitude the Arch will carry you to.

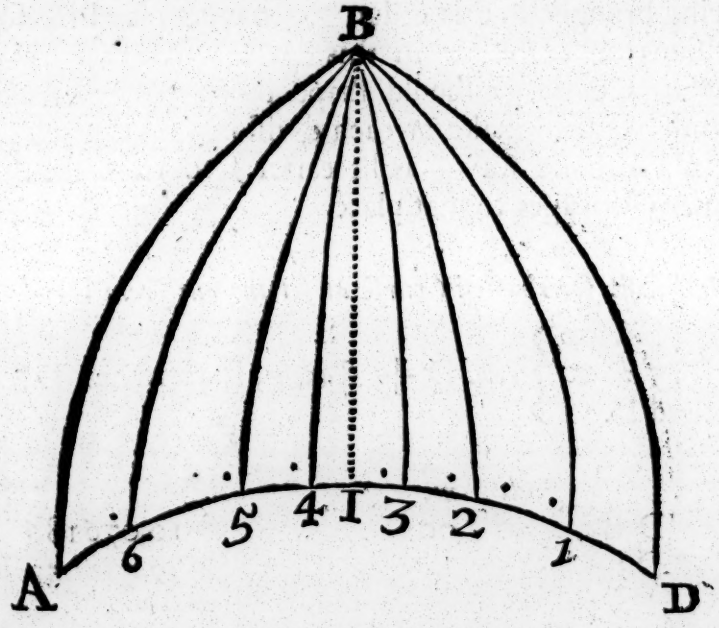
And thus you see to follow the Arch of a great Circle, you must shape your Course so, that when you are half way (in this case) you must be in the Latitude of 37 *deg.* 31′. But it's necessary in cases of this nature, at your first setting out, to calculate for every 4 degrees that you sail, a Table of direct Positions, or Courses, that will keep you in your Voyage near this Arch of a great Circle; which will be done as followeth, in all Voyages where the places be in one Parallel or Latitude. Also to set down the Latitudes that this Arch passeth by.

CASE

CASE 3.

Two places being in one Parallel or Latitude, and their neareſt diſtance in the Arch of a great Circle given; to find the direct Poſition for every 4 deg. 30 min. *of diſtance, ſayling in that Arch, and the Latitudes that this Arch paſſeth by.*

Queſt. 3. *Admit there be two places in the Latitude of* 50 deg. 00′ *North Latitude, and their diſtance in the Arch of a great Circle be* 1800 miles, *or* 30 deg. 00′; *I demand the Courſe to keep to that Arch of a Circle for every* 4 deg. 30′ *of diſtance ſailed in it.*



LEt fall the Perpendicular B I, which divides the Triangle into two right angled Triangles, whoſe ſides and Angles are equal one to the other, each to his correſpondent. Now if we begin in the Triangle B D I, counting the Arch of a great Circle that leades between theſe places A D, to be divided from D, by the Meridians B 1, B 2, B 3, B 4, B 5, B 6, into equal parts, at 4 *deg.* 30′ to a part, according to the Queſtion. Here then,

Firſt,

First, to find B I *the Perpendicular.*

Data. { I D half the nearest distance 15 *d.* 00′ / D B the Comp. of the Latit. 40 *d.* 00′ / Required I B } *s. co.* B D + *Rad.* is = to *s. co.* D I + *s. co.* I B.

		d.	*m.*		
s. co.	D I	15	00	*co. ar.*	0.01505
s. co.	B D	40	00		9.88425
s. co.	B I	37	31		9.89930

And this subſtracted from 90 *deg.* is the Northermoſt Latitude that the Arch of a great Circle will carry you to, namely 52 *deg.* 29′.

Things being brought in this order, go to work, and ſee for every of theſe diviſions or 4 *deg.* 30′ in this Arch, what Latitude we ſhall be in, and what Courſe we ſhould ſhape to keep to the Arch; alſo what Longitude we ſhall make at each diviſion as we go along; and ſet it down in a Tabuler way (as hereafter) to ſerve for the whole Voyage, or many Voyages to that place.

And firſt, for the firſt Courſe at ſetting out from D.

Data. { B D 40 *d.* 00′ / D I 15 *d.* 00′ / Required D. } *s. co.* D + *Radius*, is = to *t. co.* D B + *t.* D I

		d.	*m.*	
t. co.	D B	40	00	10.076186
t.	D I	15	00	9.428052
s. co.	D	71	23	9.504238

Next, for the difference of Longitude between the two places A B D.

		d.	*m.*	
t. co.	I D	15	00	10.57194
s.	B I	37	31	9.78461
t. co.	D B I	23	45	10.35655

Which doubled, is A B D the difference of Longitude 47 *deg.* 30′.

Thus

Thus then the first Course I steer is North 71 *deg.* 23′ Westerly; that is, West North West 3 *deg.* 57′ Westerly: set it down in the Table as you see here, and it will be read thus:

At my setting out I'll steer W N W 3 *deg.* 57′ Westerly, till from D I come to I.

Next, to find what Course I must steer from 1, *which is* 4 deg. 30′ *in my way.*

Data. { I 1 10 *deg.* 30′ / I B 37 *deg.* 31′ / Required B 1 I } *s.* I 1 + *Rad.* is = to *t.* I B + *t. co.* B 1 I.

	d.	*m.*		
B I *t.*	37	31	*co. ar.* or *t. co.*	10.11475
I 1 *s.*	10	30		9.26063
B 1 I *t. co.*	76	39		*x* 9.37538

The second Course is North 76 *deg.* 39′ Westerly, that you must steer; which is West North West 9 *deg.* 9′ Westerly.

For the Latitude I am in at 1.

			d.	*m.*	
Data. B I 37 *d.* 31′	*s. co.* B I	37	31	9.89936	
I 1 10 *d.* 30′	*s. co.* I 1	10	30	9 99266	
Required B 1.	*s. co.* B 1 its *co.*	51	15	9.89202	

For the Longitude I have made at 1.

			d.	*m.*	
Data. B I 37 *d.* 31′	*s.* I B	37	31	9.78461	
I 1 10 *d.* 30′	*t. co.* I 1	10	30	10.73203	
Required I B 1.	*t. co.* I B 1	16	56	10.41664	

Here I consider, that when I set out, I found the Angle at B, namely I B D, to be 23 *deg.* 45′, and now I find the Angle I B 1 to be but 16 *deg.* 56′; which being substracted from I B D, leaves 1 B D the difference of Longitude I have made since I set out, namely 6 *deg.* 49′; and so I set down in the Table the second line, which will be read thus:

When I have ſailed 4 *deg.* 30′ of the Arch of a great Circle that leads between theſe two places, I muſt ſteer Weſt North Weſt 9 *deg.* 9′ Weſterly, and muſt be then in the Latitude of 51 *deg.* 15′, and ſhall have Weſt Longitude from the place I ſet 6 *deg.* 49′.

Diſtance in the Arch.		COURSE.				Latitude.		Longitude.	
d.	*m.*		*d.*	*m.*		*d.*	*m.*	*d.*	*m.*
0	00	W N W	3	57	Weſterly	50	00	00	00
4	30	W N W	9	09	Weſterly	51	15	06	49
9	00	W	7	45	Northerly	52	04	13	57
13	30	W	1	53	Northerly	52	28	21	17
18	00	W	4	33	Southerly	52	21	29	29
22	30	W	9	01	Southerly	51	56	35	09
27	00	W S W	6	45	Weſterly	51	00	42	13
30	00	W S W	3	57	Weſterly	50	00	47	30

Next, for the Courſe at 2.

	d.	*m.*
I ſubſtract from I D	15	00
D 2	09	00
The remainder is 2 I	06	00

Data. { I 2 06 *d.* 00′ / I B 37 *d.* 31′ } *s.* I 2 + *Rad.* is = to *t.* I B + *t. co.* I 2 B.
Required I 2 B.

		d.	*m.*	
I B	*t. co.*	37	31	10.11475
I 2	*s.*	06	00	9.01923
I 2 B	*t. co.*	82	15	9.13398

Thus the next Courſe from 2, muſt be North 82 *deg.* 15′ Weſterly; that is, Weſt 7 *deg.* 45′ Northerly.

In

For the Latitue at 2.

				d.	m.	
Data.	I 2 06 *d.* 00′	*s. co.*	B I	37	31	9.89936
	I B 37 *d.* 31′	*s. co.*	I 2	06	00	9.99761
	Required 2 B	*s. co.*	B 1	37	56	9.89697

The Complement of 2 B (here found) is the Latitude you are in at 2, namely 52 *deg.* 4′.

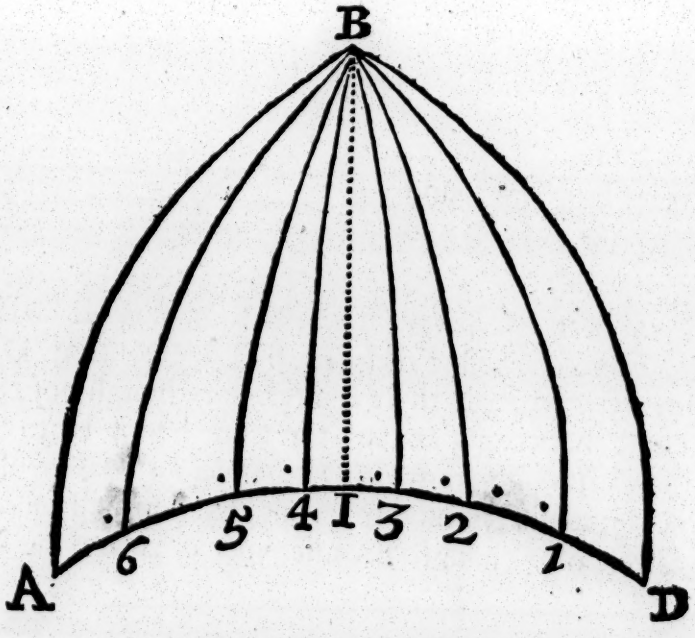
For the Longitude at 2.

				d.	m.	
Data.	I 2 06 *d.* 00′	*t. co.*	I 2	06	00	0.97837
	I B 37 *d.* 31′	*s.*	I B	37	31	9.78461
	Required I B 2.	*t. co.*	I B 2	09	58	10.76298

This being ſubſtracted from I B D — 23 *deg.* 45′

— 9 *deg.* 48′

Leaves the difference of Longitude I have made 2 B D — 13 *deg.* 57′



Thus then, when I am at 2 in the Arch of a great Circle, I muſt ſhape my Courſe Weſt 7 *deg.* 45′ Northerly; and to keep it, I ſhould

be in the Latitude of 52 *deg.* 4′, and my difference of Longitude that I ſhould make, would be 13 *deg.* 57′.

Next, for my Courſe at 3.

						d.	*m.*	
Data.	3 I	1 *d.* 30′	I B	*t. co.*		37	31	10.11475
	I B	37 *d.* 31′	I 3	*s.*		01	30	8.41791
	Required I 3 B		I 3 B	*t. co.*		88	03	8.53266

Thus the next courſe from 3 would be Weſt 1 *deg.* 53′ Northerly.

To find the Latitude I am in at 3.

		d.	*m.*				
Data.	I 3	1	30	*s. co* B I	37 *deg.* 31′	9.89936
	I B	37	31	*s co.* I 3	1 *deg.* 30′	9.99985
	required B 3			*s.co.* B 3	37 *deg.* 32′	9.89921

The Latitude you ſhould be in at 3 is 52 *deg.* 28′.

To find the Longitude the Circle paſſeth at 3.

		d.	*m.*			
Data.	I 3	1	30	*t. co.* I 3	1 *deg.* 30′	11.581932
	I B	37	31	*s.* I B	37 *deg.* 31′	9.784610
	Required I B 3			*t. co.* I B 3	2 *deg.* 28′	11.366543

From I B D	23 *deg.* 45′
Subſtract I B 3 here found	02 *deg.* 28′
The remainder is the Longit. I have made at 3	21 *deg.* 17′

If the courſe between 3 and 4 had been due Weſt, it had been rather better, becauſe the courſe for the firſt five degrees from D holding to A, as it doth at D, whereas there is alteration, though not conſiderable, and ſo likewiſe between 3 and 4; for from I to 4 is to the Southwards of the Weſt, and from I to 3 to the Southwards of the Eaſt; but theſe nicities can breed no errour, but that you will follow the Arch of a great Circle near enough, becauſe you calculate the Latitude at each place.

Next then for our Course from 4.

I consider from I to 4 it is 3 *deg.* 30′
And B I is given as before 37 *deg.* 31′
And B 4. I is required.

I B *t. co.*	37 *deg.* 31′	10.11475
I 4 *s.*	03 *deg.* 30′	8.78567
B 4 I *t. co.*	85 *deg.* 27′	8.90042

And this course is from 4 South Westerly 85 *deg.* 27′, that is West 4 *deg.* 33′ Southerly.

Next for the Latitude at 4.

		d.	m.			
Data.	I 4	3	30	*s. co.* B I	37 *deg.* 31′	9.89936
	I B	37	31	*s. co.* I 4	03 *deg.* 30′	9.99918
	Required 4 B			*s. co.* B 4	37 *deg.* 39′	9.89854

The Latitude you should be in at 4 is 52 *deg.* 21′.

For the Longitude I B 4.

		d.	m.		d.	m.	
Data.	I 4	3	30	*t. co.* I 4	3	30	1.21351
	I B	37	31	*s.* I B	37	31	9.78461
	Required I B 4			*t. co.* I B 4	05	44	10.99812

Which being added to I B D 23 *deg.* 45′

Gives the difference of Longitude at 4 29 *deg.* 29′

Next for our Course at 5.

The distance from I to 5, is given to be 4 *deg.* 30′ more than

	d.	m.
I 4 was (namely)	7	00
I B is	37	31

I 5 B is required.

	d.	m.	
I B *t. co.*	37	31	10.11475
I 5 *s.*	07	00	9.08589
I 5 B *t. co.*	80	59	9.20064

The Course is from 5 South 80 *deg.* 59′ Westerly, that is West 9 *deg.* 1′ Southerly.

For the Latitude we are in at 5.

				d.	m.	
Data.	I 5 7 *d.* 00′	*s. co.*	B I	37	31	9.89936
	I B 37 *d.* 31′	*s. co.*	I 4	07	00	9.99675
	Required B 5.	*s. co*	B 5	38	04	9.89611

The Comp. of B 5 here found, is the Latit. at 5, namely 51 *deg.* 51′.

For the Longitude at 5.

				d.	m.	
Data.	I 5 7 *d.* 00′	I 5	*t. co.*	07	00	10.91085
	I B 37 *d.* 31′	I B	*s.*	37	31	9.78461
	Required I B 5.	I B 5	*t. co.*	11	24	10.69546

This 11 *deg.* 24′ added to I B D makes 5 B D 35 *deg.* 09.

Next, for our Course at 6.

				d.	m.	
Data.	I 6 12 *d.* 30′	*t. co.*	I B	37	31	10.11475
	I B 37 *d.* 31′	*s.*	I 6	12	30	9.33533
	Required B 6 I	*t. co.*	I 6 B	74	15	9.45008

The Course is from 6 South 74 *deg.* 15′ Westerly; that is, West South West 6 *deg.* 45′ Westerly.

For the Latitude we are in at 6.

				d.	m.	
Data.	I 6 11 *d.* 30′	*s. co.*	B I	37	31	9.89936
	I B 37 *d.* 31′	*s. co.*	I 6	11	30	9.99119
	Required B 6.	*s. co.*	B 6	51	00	9.89055

The

The Side found here, is 39 *deg.* its Complement is the Latitude 51 *deg.* 00′ at 6.

Laſtly, for the Longitude at 6.

				d.	*m.*	
Data.	I 6 11 *d.* 30′	I 6 *t. co.*		11	30	10.69153
	I B 37 *d.* 31′	I B *s.*		37	31	9.78461
	Required I B 6.	I B 6 *t. co.*		18	28	10.47614

This 18 *deg.* 28′ added to 23 *deg.* 45′
Gives D B 6 42 *deg.* 13′

To prove your work, you may find the Longitude that will be made at A, and the Latitude you ſhould be in there, thus:

				d.	*m.*	
Data.	I A 15 *d.* 00′	I A *t. co.*		15	00	10.57194
	I B 37 *d.* 31′	I B *s.*		37	31	9.78461
	Required A B I.	A B I *t. co.*		23	45	10.35655

	d.	*m.*
The Longitude that is made from I ſailing to A, is	23	45
Which added to the Longitude made, ſailing in the ſame Arch from D to I, equal to it	23	45
Makes the difference of Longitude D B A	47	30

And thus you ſee, that if the diſtance from D to A be 1800 miles or 30 degrees in that Arch of a great Circle, and that the two places D and A be in one Parallel; the difference of Longitude between them is 47 *deg.* 30′. Now this difference of Longitude, if it had been run up in the Parallel of 50 degrees, would have made the Run longer than to follow the Arch of a great Circle, by 32 miles; which though it be not much in this caſe, yet it ſerves to ſhew that the Arch of a great Circle is the neareſt way, (which ſome that do not underſtand the nature of it, will not believe:) and in other caſes you will ſee a great difference, as hereafter we ſhall ſhew.

For

For the Latitude you ſhall be in at A.

				d.	m.	
Data.	I B 37 *d.* 31′	*s. co.* B I	37	31	9.89936
	I A 15 *d.* 00′	*s. co.* I A	15	00	9.98494
	Required B A.	*s. co.* B A	40	00	9.88430

Whoſe Complement to 90 *deg.* is 50 *deg.* 00′ the Latitude you ſhould be in at A.

And thus for any Voyage you may calculate your Courſe as well to every ſingle degree, 2 degrees, or for every five degrees that you ſail in the Arch of a great Circle, (which is near enough); and alſo ſee what Latitudes and Longitudes the Arch will go by at your firſt ſetting out, that ſo you may order your buſineſs thereafter in the Voyage. I am willing to be the larger in theſe things, becauſe they be of great conſequence; and I would have all men uſe this way of ſailing, where they can.

CASE 4.

Two places being propoſed, the one in the Latitude of 13 deg. 12 min. *North Eaſt, the other in the Latitude of* 50 deg. 00 min. *and the neareſt diſtance in a great Circle of the ſame being alſo known; to find their difference of Longitude, the direct Poſition of the firſt from the ſecond, and of the ſecond from the firſt.*

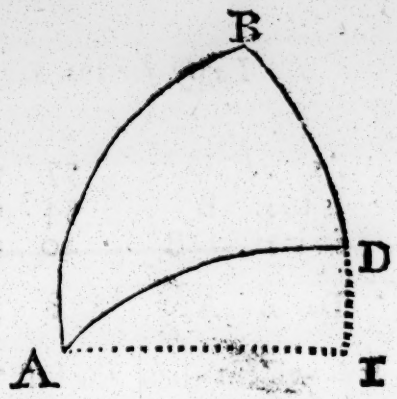
Queſt. 4 *Admit that I ſet from the* Lizard *lying, in North Latitude* 50 deg. 00′, *and am bound to* Barbados, *which lieth in North Latitude* 13 deg. 12′, *and is diſtant from the* Lizard *in the Arch of a great Circle,* 57 deg. 08′, *or* 3428 *miles, between the South and the Weſt; I demand the difference of Longitude between them, and the Angle of Poſition from the* Lizard *to* Barbados, *as alſo from* Barbados *to the* Lizard.

HEre B repreſents the North Pole; then muſt
B A be the Complement of the Latitude of *Barbados*, 76 48
B D the Complement of the Latitude of the *Lizard*, 40 00
A D the neareſt diſtance of them, 57 08

And let it be required to find the Angle B, which is the difference of Longitude.

The

	d.	m.
The side A B is	76	48
The side B D is	40	00
The difference is	36	48
The half difference	18	24
The half of A D is	28	34
Sum	46	58
Remainder	10	10



	d.	m.		
s. B D	40	00	*co. ar.*	0.19193
s. B A	76	48	*co. ar.*	0.01162
s. Sum	46	58		9.86389
s. Remainder	10	10		9.24677
				19.31421
s. half A B D	27 *deg.*	00′		9.65710
		2		
Which Doubled, is	54 *deg.*	00′	the difference of Longitude.	

Thus then the difference of Longitude between the *Lizard* and the Island of *Barbados*, is (at this rate) 54 *deg.* 00′

Next, for the Angle of Position at the Lizard, D.

	d.	m.		
As *s.* D A	57	08	*co. ar.*	0.07575
Is to *s.* B	54	00		9.90795
So is *s.* B A	76	48		9.98837
To *s.* D (its *co.* to 180 *deg.*)	69	40		9.97207

Thus then the Angle of direct Position from the *Lizard*, is 69 *deg.* 40′ to the Westwards of the South; that is, West South West 2 *deg.* 10′ Westerly.

Laſtly, for the Angle of Poſition from Barbados, A.

		d.	m.		
As *s.*	DA	57	08	*co. ar.*	0.07575
Is to *s.*	B	54	00		9.90795
So is *s.*	DB	40	00		9.80806
To *s.*	A	38	15		9.79176

It is evident then, the firſt Courſe you ſteer from *Barbados*, is North 38 *deg.* Eaſterly; that is, North Eaſt by North 4 *deg.* 30′ Eaſterly.

CASE 5.

The Latitudes of two places being given, and the difference of Longitude between them being alſo known; to find their neareſt diſtance in the Arch of a great Circle, and the direct Poſition of the firſt from the ſecond, and of the ſecond from the firſt; and by what Latitudes and Longitudes the Arch of a great Circle paſſeth.

Queſt. 5. *Admit I ſet from the* Lizard, *which is North Latitude* 50 deg. 00′ *and be bound to* Barbados, *which is in North Latitude* 13 deg. 12′ *and if* Barbados *hath Weſt Longitude from the* Lizard 54 deg. 00′; *I demand the neareſt diſtance of theſe places, and the Angle of direct Poſition from the* Lizard *to* Barbados, *and from* Barbados *to the* Lizard.

	d.	m.
HEre in the Triangle A B D, we have given B D, the Complement of the Latitude of the *Lizard*	40	00
B A the Complement of the Latitude of *Barbados*	76	48
And A B D the difference of Longitude between them	54	00

Firſt then, for A D, *the neareſt diſtance between them.*

Let fall the Perpendicular A I, and then we have given in the right angled Triangle A I B,

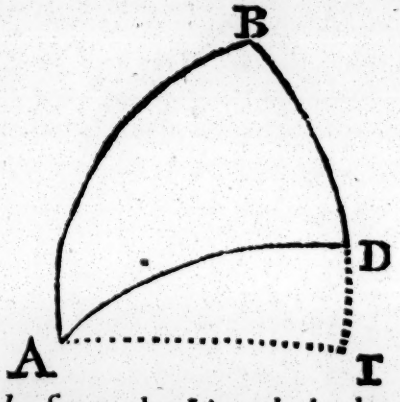
A B

			d.	m.	
AB 76 d. 48′	t.	BA	76	48	0.62976
B 54 d. 00′	s. co.	B	54	00	9.76921
To find BI.	t.	BI	68	14	10.39897

		d.	m.		
As s. co.	BI	68	14	co. ar.	0.43082
Is to s. co.	DI	28	14		9.94498
So is s. co.	BA.	76	48		9.35860
To s. co.	DA	57	08		9.73440

This 57 *deg.* 08′ converted into miles, at 60 miles to a degree, in a great Circle, gives for the number of miles between them 34 *deg.* 28′.

Secondly, for the Angle of direct Position from the Lizard D.



	d.	m.		
As s. AD	57	08	co. ar.	0.07575
Is to s. B	54	00		9.90795
So s. BA	76	48		9.98837
To s. D its co. to 180 d. ADI	69	40		9.97207

The Angle of direct Position of *Barbados* from the *Lizard*, is then South 69 *deg.* 40′ Westerly; that is, West South West 2 *deg.* 10′ Westerly.

Lastly, for the Angle at A.

	d.	m.		
As s. AD	57	08	co. ar.	0.07575
Is to s. B	54	00		9.90795
So is s. BD	40	00		9.80806
To s. A	38	15		9.79176

The Angle of Position from *Barbados* to the *Lizard*, is North 38 *deg.* 15′ Easterly; that is, North East by North 4 *deg.* 30′ Easterly. The like for any other of this kind.

We have found the neareſt diſtance between the *Lizard* and *Barbados*, in the Arch of a great Circle, to be 57 *deg.* 08′, or 3428 miles; and alſo the Angle of Poſition from the *Lizard* to *Barbados* to be 69 *deg.* 40′; and the Angle of Poſition from *Barbados* to the *Lizard* to be 38 *deg.* 15′. But now,

Admit I would know by what Latitude and Longitude this Arch of a great Circle doth paſs, that ſo I may ſet my buſineſs in order for the keeping a Reckoning from one of theſe places to the other, and to follow this Arch as near as I can.

I have ſhewed in *Queſt.* 3. how to find by what Latitudes and Longitudes the Arch of a great Circle doth paſs; but that Queſtion was wrought in an Example where the places were both in one Latitude; but in this caſe they be not in one Latitude, which differs ſomething from the former: and therefore I am willing to ſhew an Example of it. Alſo, that was wrought for degrees given upon the Arch of a great Circle, this to every fifth degree of Longitude between the places.

Suppoſe then, that I would know by what *Latitude* this Arch of a great Circle paſſeth, to every fifth degree of Longitude, and the Courſe.

In the Triangle A B D,

	d.	*m.*
Let D be the Latitude of the *Lizard*, whoſe Complement of Latitude or diſtance from the North Pole, is D B	40	00
Let A be *Barbados*, whoſe Comp. of Latitude is A B	76	48
The difference of Longitude A B D is	54	00
The Angle of direct Poſition from the *Lizard* is B D A 110 *deg.* 20′, whoſe Complement to 180 *deg.* is A D R, the Courſe from the South	69	40

For the doing this Queſtion, (in the preceding Figure) let fall the Perpendicular B I, which will fall without the Triangle, becauſe the Arch of a great Circle directs it ſelf to the Northwards of the Eaſt, as you may ſee by the Angle of Poſition but now found: for where the Perpendicular falls from the Pole, upon this Arch is the very Northermoſt point or Latitude that the Arch goes through, and muſt therefore be the place where the Perpendicular falls; becauſe there onely the Angles of Poſition (to keep that Circle) would be Eaſt and Weſt.

Firſt,

First then, to find the Perpendicular, which must be our first work.

We have given in the Triangle B I D, right angled at I,

	d.	*m.*
B D I = to A D R	69	40
D B the Complement of the Latitude	40	00

And I B the Perpendicular is required.

	d.	*m.*	
s. B D I	69	40	9.97205
s. B D	40	00	9.80806
s. I B	37	04	9.78001

Thus the Perpendicular B I is found to be 37 *deg.* 04′, which is the Complement of the Northermost Latitude; it reacheth 52 *deg.* 56′ from the Pole to the great Circle.

Next, we must find the Angle of Longitude that this Perpendicular makes without the Triangle A B D, *namely* D B I.

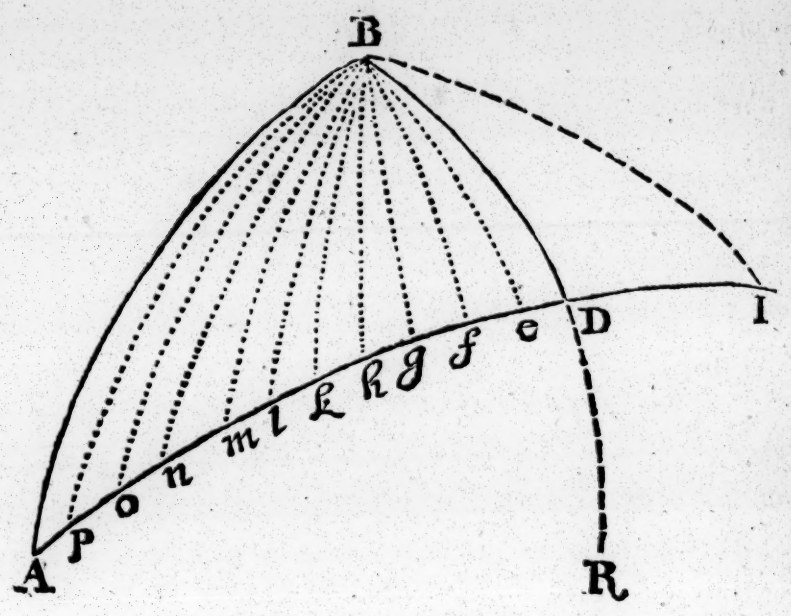
				d.	*m.*		
Data.	I D B 69 *d.* 40′	*t. co.*	I D B	69	40	*co. ar.*	0.43112
	D B 40 *d.* 00′	*s. co.*	D B	40	00		9.88425
	Required D B I.	*t. co.*	D B I	25	49		10.31537

These being found, let us proceed to find by what Latitudes this Arch of a great Circle passeth from D to A, at every five degrees of Longitude; and so the Course or Angle of Position at those degrees; I B E is 30 *deg.* 49′.

And first, for the Latitude at e, *in the Triangle* I B e.

				d.	*m.*	
Data.	I B 37 *d.* 04′	*t. co.*	B I	37	04	0.12183
	I B e 30 *d.* 49′	*s. co.*	I B e	30	49	9.93389
	Required B e.	*t. co.*	B e	41	20	10.05572

This 41 *deg.* 20′ is the Complement of the Latitude at e, 48 *deg.* 40′; so that at e we find we are in that Latitude, and must steer West South West 2 *deg.* 10′ VVesterly, from D to e. *For*



For the Course from e to f.

				d.	m.	
Data.	I B 37 d. 04′	s.	B I	37	04	9.78013
	B e 41 d. 20′	s.	e B	41	20	0.18016
	Required B e I.	s.	B e I	65	52	9.96029

For the Latitude at f.

				d.	m.	
Data.	I B 37 d. 04′	s.co.	I B f	35	49	9.90896
	I B f 35 d. 49′	t. co.	I B	37	04	0.12183
	Required B f.	t. co.	B f	42	58	10.03079

Thus from e to f we must steer South 65 *deg.* 52′ Westerly, and at f we shall be in the Latitude of 47 *deg.* 02′.

For the Course from f to g.

				d.	m.		
Data.	I B 37 d. 04′	s.	B f	42	58	co. ar.	0.16665
	B f 42 d. 58′	s.	I B	37	04		9.78013
	Required I f B.	s.	I f B	62	12		9.94678

For

For the Latitude at g.

Data. I B 37 *d.* 04′, I B *g* 40 *d.* 49′, Required B *g.*

Note, I adde at every Station the Angle of Longitude 5 *d.* increasing the Angle I B D ſo much at each Letter.

	d.	*m.*	
s. co. I B *g*	40	49	9.87898
t. co. I B	37	04	0.12183
t. co. B *g*	44	57	10.00081

From *f* to *g*, we muſt ſteer South 62 *deg.* 12′ Weſterly; and at *g* we ſhall be in the Latitude of 45 *deg.* 03′.

For the Courſe from g to h.

Data. I B 37 *d.* 04′, B *g* 44 *d.* 57′, Required I *g* F.

		d.	*m.*	
s. B *g*		44	57	0.15089
s. I B		37	04	9.78013
s. I *g* B		58	34	9.93102

For the Latitude at h.

Data. I B 37 *d.* 04′, I B *h* 45 *d.* 49′, Required B *h.*

		d.	*m.*	
s. co. I B *h*		45	49	9.8432
t. co. I B		37	04	10.1218
t. co. B *h*		47	18	9.9650

For the Courſe from h to k.

Data. I B 37 *d.* 04′, B *h* 42 *d.* 42′, Required I B *h.*

		d.	*m.*		
s. B *h*		47	18	*co. ar.*	0.13376
s. I B		37	04		9.78013
s. I *h* B		55	06		9.91389

The

The Latitudes the Circle passeth by.			The Course at every five degrees of Longitude that the Arch passeth by.			
	d.	*m.*		*d.*	*m.*	
At *e*	48	40	From D to *e* W S W	02	10	Westerly.
At *f*	47	02	From *e* to *f* S	65	52	Westerly.
At *g*	45	03	From *f* to *g* S	62	12	Westerly.
At *h*	42	42	From *g* to *h* S	58	34	Westerly.
At *k*	39	55	From *h* to *k* S	55	06	Westerly.
At *l*	36	38	From *k* to *l* S	51	48	Westerly.
At *m*	32	50	From *l* to *m* S	49	34	Westerly.
At *n*	28	28	From *m* to *n* S	45	50	Westerly.
At *o*	23	30	From *n* to *o* S	43	17	Westerly.
At *p*	17	58	From *o* to *p* S	41	05	Westerly.
At A	13	12	From *p* to A S	39	18	Westerly.

For the Latitude at k.

				d.	*m.*		
Data.	I B 37 *d.* 04′	*s. co.*	I B *k*	50	49		9.80058
	I B *k* 50 *d.* 49′	*t. co.*	I B	37	04		10.12183
	Required B *k.*	*t. co.*	B *k*	50	05		9.92241

For the Course from k to l.

				d.	*m.*		
Data.	I B 37 *d.* 04′	*s.*	B *k*	50	05	*co. ar.*	0.11521
	B *k* 50 *d.* 05′	*s.*	I B	37	04		9.78013
	Required I *k* B.	*s.*	B *k* I	51	48		9.89534

For the Latitude at l.

				d.	*m.*		
Data.	I B 37 *d.* 04′	*s. co.*	I B *l*	55	49		9.74961
	I B *l* 55 *d.* 49′	*t. co.*	I B	37	04		0.12183
	Required B *l.*	*t. co.*	B *l*	53	22		9.87144

Fr

For the Course from l to m.

				d.	m.		
Data.	B I 37 d. 04′	s. B l		53	22	co. ar.	0.10131
	B l 53 d. 22′	s. B I		37	04		9.78013
	Required I l.	s. I l		49	34		9.88144

For the Latitude at m.

				d.	m.		
Data.	I B 37 d. 04′	s. co. I B m		60	49		9.68806
	I B m 60 d. 49′	t. co. I B		37	04		0.12183
	Required B m.	t. co. B m		57	10		9.80989

For the Course from m to n.

				d.	m.		
Data.	B I 37 d. 04′	s. B m		57	10	co. ar.	0.07559
	B m 57 d. 10′	s. B I		37	04		9.78013
	Required I m B.	s. I m B		45	50		9.85572

For the Latitude at n.

				d.	m.		
Data.	B I 37 d. 04′	t. co. I B		37	04		0.12183
	I B n 65 d. 49′	s. co. I B n		65	49		9.61242
	Required B n.	t. co. B n		61	32		9.73425

For the Course from n to o.

				d.	m.		
Data.	B I 37 d. 04′	s. I B		37	04		9.78013
	B n 61 d. 32′	s. B n		61	32		0.05596
	Required I n B.	s. I n B		43	17		9.83609

For the Latitude at o.

					d.	m.		
Data.	B I	37 *d.* 04′	*t. co.*	I B	37	04		0.12183
	I B *o*	70 *d.* 49′	*s. co.*	I B *o*	70	49		9.51665
	Required B *o.*		*t. co.*	B *o*	66	30		9.63848

For the Course from o to p.

					d.	m.		
Data.	B I	37 *d.* 04′	I B	*s.*	37	04		9.78013
	B *o*	66 *d.* 30′	B *o*	*s.*	66	30	*co. ar.*	0.03760
	Required I *o* B.		I *o* B	*s.*	41	05		9.81773

For the Latitude at p.

					d.	m.		
Data.	B I	37 *d.* 04′	*t. co.*	I B	37	04		0.12183
	I B *p*	75 *d.* 49′	*s. co.*	I B *p*	75	49		9.38921
	Required B *p.*		*t. co.*	B *p*	72	02		9.51104

For the Course from p to A.

					d.	m.		
Data.	B I	37 *d.* 04′	*s.*	B *p*	72	02	*co. ar.*	0.02171
	B *p*	72 *d.* 02′	*s.*	B I	37	04		9.78013
	Required B *p* I.		*s.*	B *p* I	39	18		9.80184

For the Latitude at A.

					d.	m.		
Data.	B I	37 *d.* 04′	*t. co.*	B I	37	04		0.12183
	I B *p*	79 *d.* 49′	*s. co.*	I B *p*	79	49		9.24747
	Required A B.		*t. co.*	A B	76	48		9.36930

Thus you see when you come to *p*, you will be in the Latitude of 17 *deg.* 58′. Now I would wish every man to haul into his Latitude, before he runs his Longitude up; and therefore, when you are at *p*, you

you may leave the Arch of a great Circle, and ſteer more Southerly, ſo as that you may get into 13 *deg.* 12′, before your Longitude is out, by 100 leagues at leaſt, for fear your Judgment ſhould be out in counting your Longitude. And thus having calculated your *Courſe*, and the *Latitudes* by which the Arch of a great Circle paſſeth, it ſerves for any Voyage from the *Lizard* to that place.

You may calculate your Courſe to every ſingle degree of Longitude, if you will; but this (I think) is near enough: for though the Courſe alters by little and little, yet not ſo conſiderably as to require me to ſteer any otherwiſe than in this manner.

To follow the Arch of a great Circle, I believe a man might come near the Weſtern Iſlands; but it's a common thing, and they are very bold ſhores, and no danger about them, but what is to be ſeen time enough.

CASE 6.

Admit I would know how far I ſhall ſail upon the Arch of a grea Circle, to alter my Courſe any number of degrees of the Compaſs propoſed, and alſo what difference of Longitude I ſhall make, and what Latitude I ſhall be in.

Queſt. 6. *Admit I ſet from the* Lizard, *and be bound to the Iſland of* Barbados, *and the firſt direct Courſe that I ſteer from the* Lizard, *be Weſt South Weſt* 2 deg. 10′ *Weſterly, or South* 69 deg. 40′; *I demand how far I ſhall ſail before I alter my Courſe* 5 deg. 00′ *to follow the Arch of a great Circle.*

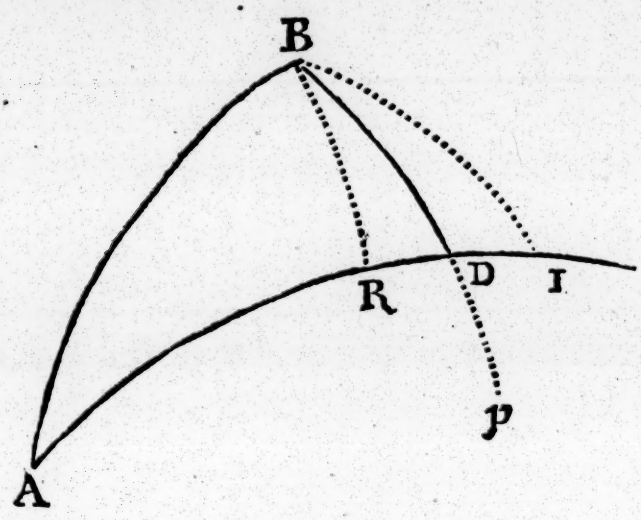
I Have ſaid, that to follow the Arch of a great Circle, the Courſe alters by degrees, and not at once: ſo that though at the firſt ſetting out at D, I ſteer Weſt South Weſt 2 *deg.* 10′ Weſterly, yet the Courſe muſt alter gradually. Now the Queſtion is, how many miles I ſhall ſail, to alter my Courſe 5 *deg.* 00′.

Imagine we muſt come to R from D, before we alter our Courſe 5 degrees; then the diſtance D R, is the thing here required.

Now for the finding it, we have in the right angled Triangle B I D, the Angle B D I, (it being the firſt Courſe at your ſetting out from D = to A D *p*) and the Complement of the Latitude of the *Li-*

ward DB; to find the Perpendicular B I, which we did in the laſt Example, and it is 37 *deg.* 04′.

And then find I B D, with the ſame things (we found it in the laſt Example to be 25 *deg.* 49′.)



So that in the Triangle B R I, right angled at I, we have given,

	d.	*m.*		
B R I	64	40	*t. co.*	9.67523
The Perpendicular I B	37	04	*t.*	9.87816
To find R I	20	57	*s.*	9.55339

Secondly, for D I.

			d.	*m.*	
Data.	B I 37 *d.* 04′	*t.* B I	37	04	9.8781
	I D B 69 *d.* 40′	*t. co.* I D B	69	40	9.5688
	Required D I.	*s.* D I	16	15	9.4469

	d.	*m.*
VVe found R I to be	20	57
From which ſubſtract D I now found,	16	15
The remainder is D R required	04	42

Thus you ſee then we muſt ſail 4 *deg.* 42′ on the Arch of a great Circle, before you need alter your Courſe 5 degrees of the Compaſs; every

every degree upon the Arch of a great Circle, is 60 miles: ſo that this 4 *deg.* 42′ is 282 miles.

Next, for the Latitude at R.

If you ask how the Angle B R I was given in this and the laſt Example, you may note, the Queſtion gives the Angle at R, to differ from the Angle at D 5 degrees; which muſt make I R B 5 degrees leſs than I D B.

				d.	*m.*		
Data.	B I 37 *d.* 04′	*s.* R		64	40	*co. ar.*	0.04391
	B R I 64 *d.* 40′	*s.* B I		37	04		9.78013
	Required B R.	*s.* R B		41	50		9.82404

This R B ſubſtracted from 90 *deg.* leaves the Latitude this Arch paſſeth at R 48 *deg.* 10′.

Laſtly, for the difference of Longitude D B R.

				d.	*m.*		
Data.	I B 37 *d.* 04′	*t.* B I		37	04		9.87816
	R B 41 *d.* 50′	*t. co.* B R		41	50		0.05319
	Required I B R.	*s. co.* R B I		31	22		9.93135

				d.	*m.*		
Data.	I B 37 *d.* 04′	*t.* B I		37	04		9.87816
	B D 40 *d.* 00′	*t. co.* B D		40	00		0.07618
	Required I B D.	*s. co.* I B D		25	49		9.95434

	d.	*m.*
Here we have found I B R to be	31	22
From which ſubſtract I B D	25	49
And the remainder is D B R the Longitude that is made at R required.	05	33

CASE

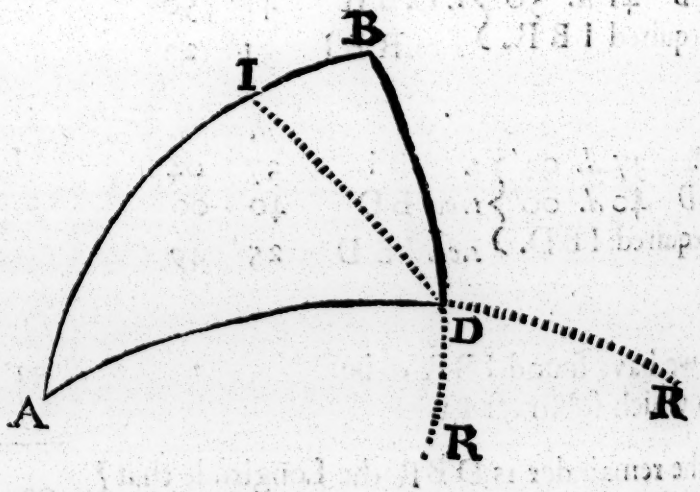
CASE 7.

The Latitude of a place given, the neareſt diſtance of that place from another, being alſo given, with the difference of Longitude between them; to find the direct Poſition of the other from it, alſo the Latitude the other lies in.

Queſt. 7. *Admit the neareſt diſtance from the* Lizard *to* Barbados *be* 3428 *miles, or* 57 deg. 08′, *and that* Barbados *hath Weſt Longitude from the* Lizard 50 deg. 00′; *I demand (provided the* Lizard *lies in the Latitude of* 50 deg. 00′) *what Latitude* Barbados *lies in, and the Angle of Poſition from the* Lizard *to* Barbados, *or from* Barbados *to the* Lizard.

IN the Triangle A B D we have given the Longitude between them, d. m.

D B A	54	00
D B the Complement of the Latitude of the *Lizard*	40	00
D A the neareſt diſtance in the Arch of a great Circle	57	08



Firſt, *for the Angle of Poſition from* Barbados *to the* Lizard, A.

			d.	m.		
As	*s.*	D A	57	08	*co. ar.*	0.07575
To	*s.*	B	54	00		9.90795
So	*s.*	B D	40	00		9.80806
To	*s.*	A	38	15		9.79176

After

After the same manner, if the Complement of the Latitude of the *Barbados* had been the Latitude given, you would have found the Angle of direct Position from the *Lizard* D.

To find the Latitude of Barbados, *the Complement of which is* A B.

We will let fall the Perpendicular D I, and so the Triangle A D B is divided into two right angled Angles, namely D I B and D I A.

In the Triangle D B I.

				d.	m.	
Data.	B D 40 *d.* 00′	*t.*	B D	40	00	9.92381
	D B I 54 *d.* 00′	*s. co.*	I B I	54	00	9.76921
	Required B I.	*t.*	B I	26	15	9.69302

			d.	m.		
As	*s. co.*	B D	40	00	*co. ar.*	0.11574
Is to	*s. co.*	D A	57	08		9.73454
So is	*s. co.*	I B	26	15		9.95273
To	*s. co.*	I A	50	33		9.80301

	d.	m.
Now if to this I A here found	50	33
You adde I B before found	26	15
It gives B A the Complement of the Latitude at A	76	48
Whose Latitude is required	13	12

Lastly, for the Angle of Position from the Lizard A D B.

			d.	m.		
As	*s.*	A B D	40	00	*co. ar.*	0.19193
To	*s.*	A	38	15		9.79175
So	*s.*	B A	76	48		9.98837
To	*s.*	B D A its *co.* to 180 *deg.* A D R = to B D R	69	40		9.97205

The Angle of Position required at D, then is thus found to be 69 *d.* 40′
The like is to be understood for any other of this nature.

CASE

CASE 8.

Two places being known, the one to be under the Equinoctial, the other in any other Latitude given, with the difference of Longitude between them; to find their neareſt diſtance in the Arch of a great Circle, the direct Poſition of the ſecond place from the firſt, and of the firſt place from the ſecond.

Queſt. 8. *Admit there be a place under the Equinoctial, another place in North Latitude* 49 deg. 00′, *and lying to the Eaſtwards of the Meridian of it* 38 deg. 00′; *I demand the neareſt diſtance between theſe places, and their Poſition or Angle of bearing (in the Arch of a great Circle) at firſt ſetting from each of them.*

WE may work this either by the Complements of the given Latitudes, or by the Latitudes themſelves; if we work by the Complements of the Latitudes, one ſide of the Triangle is 90 degrees; but if you work by the Latitudes themſelves, then you will have one Angle a Right Angle. I will touch upon both, but reſolve it firſt in the right angled Triangle following; in which

Let A repreſent the place under the Equinoctial.

Let B be the place in the Latitude of 49 *deg.* 00′.

Then is B D an Arch of the Meridian from that Northermoſt place to the Equinoctial, and cuts ſo far to the Eaſtwards of the place in the Equinoctial, as between it and that place is the difference of Longitude A D 38 *deg.* 00′.

And A B is the neareſt diſtance between them in the Arch of a great Circle.

A is the Angle of Poſition at the place under the Equinoctial.

B is the Angle of Poſition from that place in the Latitude of 49 *deg.* 00′.

The Angle at D is a Right Angle.

In

In this Triangle then,

Data. { D B 49 *d.* 00′ / D A 38 *d.* 00′ } *s.co.* B A + *Rad.* is = to *s.co.* B D + *s.co.* D A
Required B A.

		d.	*m.*	
s. co.	B D	49	00	9.81694
s. co.	D A	38	00	9.89653
s. co.	B A	58	52	9.71347

Their neareſt diſtance in a great Circle B A is 58 *deg.* 52′, or 3532 miles.

For the Angle of Poſition at A.

					d.	*m.*		
Data.	D B 49 *d.* 00′	B D	*t.co.*		49	00		9.93916
	D A 38 *d.* 00′	A D	*s.*		38	00		9.78934
	Required A.	A	*t.co.*	East	61	51	Norly	9.72850

For the Angle of Poſition at B.

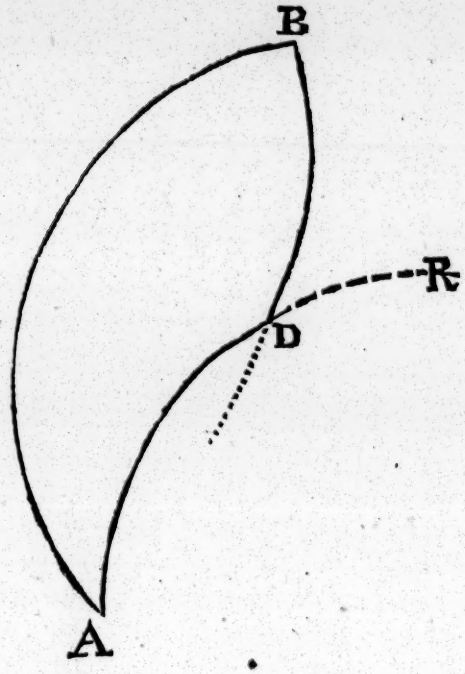
					d.	*m.*		
Data.	B D 49 *d.* 00′	*t.co.*	D A		38	00		0.10719
	D A 38 *d.* 00′	*s.*	D B		49	00		9.87777
	Required B.	*t.co.*	B	South	46	00	Weſtly	9.98496

The like may be done for any other Queſtion of this nature, where none of the Sides or Angles are above 90 *deg.* but you may work this in another Triangle from the Pole, thus:

In the following Triangle A B D.

LEt B repreſent the North Pole, A the place under the Equinoctial, D the place that is in the Latitude of 49 *deg.* 00′, then is A B 90 *deg.* 00′.

B D is the Complement of the Latitude of the place at D Comp. 49 *deg.* 00′.



D A is the neareſt diſtance between the two places in a great Circle.
B D A is the Angle of Poſition from the Northermoſt place.
D A B the Angle of Poſition from the place under the Equinoctial.
And theſe are the parts of this Triangle.

Now in this Caſe we have given,

	d.	*m.*
D B the Complement of the Northermoſt Latitude	41	00
D B A the difference of Longitude	38	00
And the ſide A B is a right ſide or	90	00

Firſt then, for B D A, *or* B D R, *its Complement to* 180 deg.

s. co. B D + *Radius*, is = to *t. co.* B + *t. co.* B D A.

	d.	*m.*		
t. co.	38	00	A B D	0.10719
s. co.	41	00	B D	9.87777
t. co.	46	00	B D R	9.98496

Thus

Thus the Courſe at firſt ſetting out from D, is B D R = to A D O South 46 *deg.* 00′ Weſterly.

For the Angle of Poſition at A.

Data. { D B 41 *d.* 00′ / D B A 38 *d.* 00′ / Required A. } *s.* B + *Radius*, is = to *t.* A + *t. co.* B D.

		d.	*m.*		
s.	B	38	00		9.78934
t. co.	B D	41	00	*co. ar.*	9.93916
t. co.	A	61	51		9.72850

Laſtly, for the neareſt diſtance D A.

Data. { D B 41 *d.* 00′ / B 38 *d.* 00′ / Required D A. } *s. co.* D A + *Rad.* is = to *s. co.* B + *s.* B D.

		d.	*m.*	
s. co.	B	38	00	9.89653
s.	B D	41	00	9.81694
s. co.	D A	58	52	9.71347

Thus the neareſt diſtance of theſe places is 58 *deg.* 52′.

And this you ſee every way agrees with the former Example of the right angled Triangle.

CASE 9.

Two places being known, the one to be under the Equinoctial, the other in any Latitude given, and the neareſt diſtance of theſe places being alſo known; to find the difference of Longitude, the direct Poſition of the firſt to the ſecond, and of the ſecond from the firſt.

I Suppoſe the places to be the ſame as before, and ſo the ſame Figures may ſerve for their demonſtration; and let there be given in

The right angled Triangle A D B,

	d.	*m.*	
The neareſt diſtance between the places B A	58	52	or 3532 miles
The difference of Latitude between them D B	49	00	

Firſt, for the Angle of Poſition at B.

s. co. B + *Radius*, is = to *t.* B D + *t. co.* B A.

		d.	*m.*	
B A	*t. co.*	58	52	9.78106
B D	*t.*	49	00	10.06083
B	*s. co.*	46	00	9.84189

Secondly, for the Angle at A.

s. B D + *Radius*, is = to *s.* B A + *s.* A.

	d.	*m.*			
B A	58	52	*s.*	*co. ar.*	0.06754
D B	49	00	*s.*		9.87777
A	61	51	*s.*		9.94531

Thirdly,

Thirdly, for the difference of Longitude D A.

s. co. B A + *Radius*, is = to *s. co.* A D + *s. co.* D B.

		d.	*m.*		
s. co.	B D	49	00	*co. ar.*	0.18305
s. co.	B A	58	52		9.71351
s. co.	D A	38	00		9.89656

The ſame might be done in the Triangle A B D, which hath the ſide B A 90 *deg.* for in it you have given,

	d.	*m.*
D B the Complement of the Latitude of the Northermoſt place	41	00
D A the neareſt diſtance of the places in a great Circle	58	52
Beſides the ſide A B, which is	90	00

Whereby you may find the other things required, with the ſame eaſe as you reſolved the Triangle upon another demand in the Caſe before this.

This may ſuffice for the *Caſes* of *Great Circle Sailing*; which though it may be varied 60 ſeveral ways in a Triangle, yet all will fall under one of theſe Caſes.

A POSTSCRIPT Concerning the Longitude.

FOR the finding the Longitude of the place where you are, and how much it differs from the Meridian you ſet from, it's meet that you have Tables of the Suns Place and Right Aſcenſion calculated in *Degrees*, *Minutes*, and *Seconds*; and I had thoughts to have done it, and placed them here: but conſidering they will ſwell the Book to a greater Volume, and how eaſie 'tis to find them, and indeed how ſatisfactory to the perſon concerned, I have thought good to ſhew two or three Examples of finding them; and ſo the time of Night, by obſerving the Altitude of ſome known Stars. I confeſs, I ſhewed how to find them before, but have not done any Examples to that exactneſs, as in this caſe is requiſite, (nor had I ſhewed how to find the time of Night.) I count 'tis but little more labour to find the Suns Right Aſcenſion and Place, than to do the other part of the Queſtion, which is to find the time of the Night by them. And this I do inſtead of Tables, which do not laſt always, nor are they in every Book; and where they are, they be not calculated any nearer than to a minute of Time for the moſt part.

QUEST I.

In this Example the Suns Right Aſcenſion is leſs than that of the Stars.

Admit the 10th *day of* April 1685, *I would know the Suns true Place and Right Aſcenſion, alſo the time of the Night exactly, that I obſerve the Altitude of the Lions Tail to be* 50 deg. 20 min. *riſing, provided I be in the Latit. of* 40 d. 10'.

I Look in the Tables, and find the Suns Declination the firſt of *April*, is Northerly } 11 *deg.* 49'

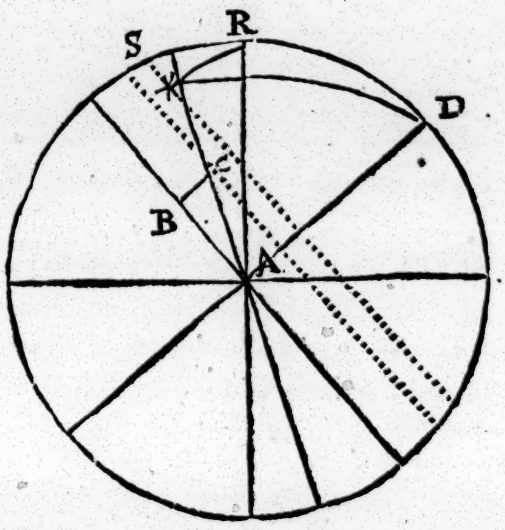
The

The Right Ascension of the Lions Tail is 172 *deg.* 58′
The Declination of the Lions Tail is Northerly 16 *deg.* 28′

First then, for the Suns Place and Right Ascension, in the Triangle A B C, *right angled at* B.

	d.	*m.*
I have given the Suns greatest Declination B A C	23	30
The Suns present Declination B C	11	49

To find B A and A C, the Suns Right Ascension and Place.



And first, for his Right Ascension A B.

s. B A + *Radius*, is = to *t. co.* A + *t.* B C.

		d.	*m.*	
t. co.	B A C	23	30	10.36169
t.	B C	11	49	9.32059
s.	B A	28	45	9.68228

The Suns Right Ascension is 28 *deg.* 45′, or 1 *ho.* 55′.]

For

For the Suns Place.

		d.	m.		
s.	BAC	23	30	*co. ar.*	0.39930
s.	BC	11	49		9.31128
s.	GA	30	54		9.71058

The Suns Place is 30 *deg.* 54′.

For this occaſion, it's no great matter whether you had found the Suns Place or no, for we ſhall not uſe it: However, you ſee it's ſoon done.

For the Stars hour ſhort from the Meridian * DR.

I have given in the Triangle * DR,

	d.	m.
The ſide * D the Complement of the Stars Declination	73	32
The Complement of the Latitude R D	49	50
The Complement of the Stars height * R	39	40

And it's required to find R D *.

	d.	m.
Half the ſide R * is	19	50
Half the difference of the ſides D R and D * is	11	51
Sum	31	41
Remainder	07	59

	d.	m.		
s. DR	49	50	*co. ar.*	0.116809
s. D*	73	32	*co. ar.*	0.018188
s. The Sum	31	41		9.720344
s. The Remainder	07	59		9.142655
				18.997996
	d.	m.		
The half of * D R	18	23		9.498998
		2		
The Angle * D R is	36	46		

So much is the Star ſhort of being upon the Meridian. There-

Therefore for the time of Night that the Star comes upon the Median,

	d.	*m.*
The Right Aſcenſion of the Star is	172	58
The Right Aſcenſion of the Sun is found to be	028	45
The time in degrees that the Star comes after Noon upon the Meridian, is	154	15

	h.	*'*	*''*
Which converted into time, is the real time after Noon that the Star comes upon the Meridian,	10	16	52

So that it ſeems the *Lions Tail* will be upon the Meridian at ten of the clock 16′ 52″.

Laſtly, to find the time of Night that I obſerved at.

	h.	*'*	*''*
We have found that the Star comes upon the Meridian at	10	16	52
And we have found that when we obſerved, the Stars Angle of its hour from the Meridian of South, was 36 *deg.* 46′ ſhort of the Meridian,	02	27	04
The remainder is the true hour, and minute, and ſecond of the Night we obſerved at, which is	07	49	48

Therefore if we ſubſtract it (converted into time) from that,

QUEST 2.

In this Example the Suns Right Aſcenſion is more than the Stars is.

Admit the 5th *day of* November 1685, *I would know the Suns Place and Right Aſcenſion, alſo the time of Night exactly that I obſerve the* Lions Tail *when he is* 40 deg. 00 min. *high, provided I be in the Latitude of* 50 deg. 00 min. *North Latitude, and the Star be riſing.*

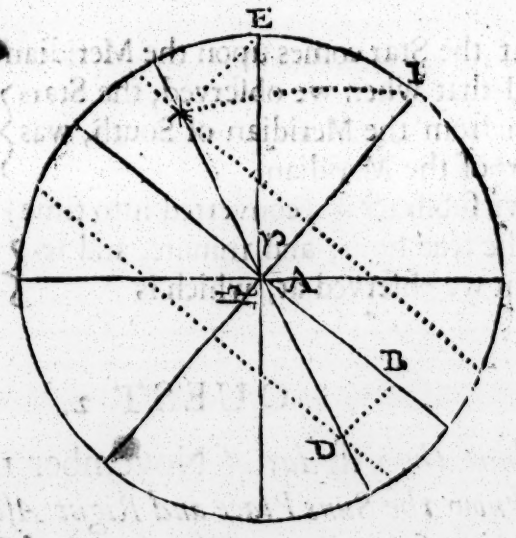
I Look in the Table and find the Suns Declination is Southerly	18 *deg.*	45′
The Right Aſcenſion of the *Lions Tail*, as before, is	172 *deg.*	58′
The Declination of the *Lions Tail* is	16 *deg.*	28′

First then, for the Suns Place and Right Ascension.

Data.	The Suns greatest Declination B A D 23 *d.* 30′ *t. co.*	10.36169
	The Suns present Declination B D 18 *d.* 45′ *t.*	9.53078
	The Suns Right Ascension A B required, is 51 *deg.* 19′ from ♎ *s.*	9.89247

Data.	B A D *s.* 23 *deg.* 30′ *co. ar.*	0.39930
	B D *s.* 18 *deg.* 45′	9.50709
	D A *s.* 53 *deg.* 43′ the Suns place required.	9.90639

As I said (in the Question before) there was no necessity of finding the Suns Place in the Ecliptick, because in this case we don't use it; but I found it to make that Example of finding the Suns Place and Right Ascension the more plain.



Again, *To find the Stars hour short of the Meridian.*

I have given in the Triangle * E I the Complement of the Stars Declination,

* I	73 *deg.* 32′
I E the Complement of the Latitude	40 *deg.* 00′
The Complement of the Stars height * E	50 *deg.* 00′

And it's required to find * I E the hours and minutes that the Star is short of the Meridian,

Half

Half the ſide E * is .		25 *deg.* 00′
Half the difference of the ſides I * and I E is		16 *deg.* 46′
	Sum	41 *deg.* 46
	Remainder	08 *deg.* 14′

	d.	*m.*		
s. I E	40	00	*co. ar.*	0.1919
s. I *	73	32	*co. ar.*	0.0181
s. Sum	41	46		9.8235
s. Remainder	08	14		9.1559
				19.1894
Half * I E, is	23 *deg.*	10′		9.5947
		2		
Doubled, is	46 *deg.*	20′	*I E,	

The time in degrees and minutes that the Star wants of being upon the Meridian; which converted into time, is 3 *ho.* 5′ 20″.

Now for the time of Night that this Star comes upon the Meridian.

Subſtract the Suns Right Aſcenſion from the Right Aſcenſion of the Star, which I cannot do here, becauſe the Suns Right Aſcenſion is more than the Stars; and therefore to ſupply that defect, adde 360 degrees (which is 24 hours) to the Right Aſcenſion of the Star, and then do it; and the remainder converted into time, is the time after Noon of the Stars coming upon the Meridian.

The Stars Right Aſcenſion is	172 *deg.* 58′
To which I adde	360 *deg.* 00′
And it makes	532 *deg.* 58′

The Right Aſcenſion of the Sun we found to be 51 *deg.* 19′ from ♎, which is at A. Now from ♈ to ♋ is 90 *deg.* and from ♋ to ♎ is 90 *deg.* more (that's 180 *deg.* and this 51 *deg.* 19′ more:) ſo that I adde the Suns Right Aſcenſion that we found to

	51 *deg.* 19′
	180 *deg.* 00′
And that ſum is the Suns Right Aſcenſion required	231 *deg.* 19′

Now then,

	d.	m.
From the Right Ascension of the Star (with 360 *deg.* added)	532	58
Substract the Suns Right Ascension	231	19
The remainder is	301	39

Which converted into time, is 20 *ho.* 06′ 36″, which is the time after 12 of the Clock that this Star comes upon the Meridian, which is at 8 a Clock 6′ 36″ in the Morning.

Lastly, for the time of Night that I took my Observation.

	ho.	′	″
From the time of the Stars coming upon the Meridian	8	06	36
I substract the time the Star was short of the Meridian when I observed	3	05	20
And it gives me the time in the Morning of my observing	5	01	16

These things I would have every man perfect in, they being of great consequence for several occasions, and especially to know the Stars by: for by knowing the Magnitude of a Star, and his time of coming to the Meridian, as also his Declination (a man cannot mistake that Star.)

Also by knowing at one time when a Star comes to the Meridian, a man may know at other times when that Star will come upon the Meridian: for the Star that will be upon the Meridian at 8 of the Clock 6′ 36″ in the Morning, will (fifteen days after) be upon the Meridian at near 7 *ho.* 6′ 36″, and fifteen days after that, again at 6 a Clock 6′ 36″, and fifteen days after that (which is forty five days from the first) 5 a Clock 6′ 36″, and fifteen days after at 4 a Clock 6′ 36″, *&c.* (I say near upon the Meridian at these times) methinks my Fraternity might know the Stars a great deal better than they generally do, (Mariners I mean) and more of them than they do, if they would give but heed to these easie ways which I here prescribe.

I confeſs the occaſion of handling this matter ſo fully here (eſpecially for finding the time of Night by obſerving the Altitude of a known Star at any time) is in order to the continual occaſion we have for it, when we take our Obſervations for the Longitude.

QUEST. 3.

Imagine there was a Star that was falling, and before he ſet I obſerved his Altitude to be as in the caſe before (when he was 40 deg. 00 min. *high), and ſuppoſe it to be the ſame day of the month (namely, the* 5th *of* November 1685, *and let the Declination of the Star be* 16 deg. 28 min. *Northerly, as this was; I demand the time of Night that I obſerved (provided I be in the Latitude of* 50 deg. 00 min.) *and the time of this Stars coming to the Meridian (provided that his Right Aſcenſion be* 108 deg. 00 min.)

IN the former Scheme, we may imagine the Triangle * E I to be to the Weſtward of the Meridian of South, juſt as in that Queſtion it falls to the Eaſtwards; and ſo we have the ſame things given in it to find the time of the Stars being paſt the Meridian, namely the three ſides to find the Angle * I E, which muſt come to the ſame it was there

	46 *deg.* 20′
or in time	3 *ho.* 5′ 20″

So I conclude the Star was upon the Meridian ſo long ſince.

Next, for the time of the Stars coming upon the Meridian.

	d.	′	″
I adde 360 *deg.* to the Stars Right Aſcenſion in the Queſtion, (becauſe I cannot take the Suns Right Aſcenſion from it)	108	00	00
And it makes	468	00	00
From which I ſubſtract the Right Aſcenſion of the Sun	231	19	00
And the remainder is the time of the Stars coming upon the Meridian after Noon	236	41	00

Which converted into time, is 15 *ho.* 46′ 44″;
Which being calculated, is at 3 a clock 46′ 44″ in the morning.

Laſtly,

Laſtly, for the time I obſerved.

	h.	′	″	
I conſider it was as I have found it here after the Star was upon the Meridian:	3	05	20	
So that if I adde it to the time of the Stars coming to the Meridian	3	46	44	.
It gives the exact time I obſerved, which was at	6	52	04	in the morning

The like for any other of this nature. As I ſaid before, I would wiſh every one to practiſe theſe things; for they be very neceſſary for them that uſe the Sea to know.

Of the Variation of the Compaſs.

I have noted before in this Book, that the *Variation of the Compaſs* is the difference between the *Magnetical* Riſing or *Amplitude* of the Sun, and his *true* Riſing and Setting; or between his true *Azimuth*, and his *Magnetical Azimuth*; for ſo much as the Compaſs varies from that, ſo much the Compaſs is falſe, and it's called the *Variation of the Compaſs*. Now for the Cauſes of this Variation, ſome have undertaken to give Reaſons; but their Philoſophical account is not arrived to any perfection of belief, nor doth it agree with that quality.

I remember when I went to the Weſt Iſle, I took all the notice I could of the *Variation of the Compaſs*, and found little alteration from what it is in *England*, till I came into (as I remember) 72 *deg.* (or thereabouts) and then I had 22 *deg.* Variation, all at once, (as it were) and it continued ſo that whole Voyage, till I came to croſs that Latitude again; and then I loſt it after the ſame manner that I found it, (ſuddenly.) I do ſuppoſe that this Variation is ſo along the ſide of the Iſle: for at *New-found-land* the Variation alters after the ſame manner (as I have credibly been informed) which makes me think it is cauſed by ſomething on the Earth and Sea; but I think every body had better employ their time and wit to calculate it truly, than to inquire the cauſe of ſo hidden a Secret: and therefore we'll fall to that next, and ſhew how it's to be done by the *Azimuth Compaſs*.

The

The Deſcription and Uſe of the Azimuth Compaſs.

THis Compaſs hath a Card in a round Box, with a Steel Needle in it touched with the Load-ſtone (as our common Mariners Compaſs is) but upon the Card is no more points drawn but the Eaſt and Weſt, North and South, (and to diſtinguiſh them) upon the North point is a Flower de Luce; alſo within upon the Box is run down Lines that anſwer theſe points; when the Flower de Luce points to one of them, the other three points muſt ſucceſſively point at the reſt; above, under the Glaſs, is alſo Threads cut at Right-Angles to theſe Lines that run down the ſides of the Box, that ſo from them you more exactly diſcern the degrees that the Index cuts from the North and South, Eaſt or Weſt. Now upon this Box is placed a Circle of Braſs, and that hath the one half of it divided into 90 *deg.* but theſe degrees are numbred from the middle of the ſaid diviſions each way, to 45 *deg.* and them ſub-divided into minutes by the deagonal Lines and Circles that you ſee there; the Center (theſe degrees is drawn from) is on the oppoſite part of the braſs Circle, whereon the Index moves, whoſe edge cuts the degree and minute in time of obſervation.

Upon the Index is a Sight of braſs which is to fall down or ſet up at pleaſure. Now from the top of this braſs Sight is a Thread that comes down to the middle of the Index, and that ſhews the ſhadow of the Sun upon a Line on the middle of the ſame.

This Compaſs being compleated, hangs in a ſquare Box of Wenſcote being well faſtened there with braſs Pins.

The Uſe of the Azimuth Compaſs.

WHen I firſt ſee one (the Uſe of them is ſo plain and eaſie) that I obſerved with it immediately; for indeed it naturally preſents you with its own uſe. But however, I'll ſay ſomething to it: Be ſure to rectifie the Circle of braſs, by the Needle or Card within the Box, according to the quality of your Obſervation; for if the Sun be to the Eaſtwards, put the Center of the Index over the Weſt point of the Card, ſo that the four Lines on the Box that runs down to the edge of the Card within, and the Points or Lines on the Gard do concur.

cur. If the Sun be to the Westwards, do the like on the East point of the Card.

The Instrument being thus fitted and set, turn the Index so that the shadow of the Thread fall into the slit of the Sight that stands upon it, (and at the same time) upon a streight Line that is in the middle of the Index, and the inner edge of which cuts the degrees upon the brass Circle, and so gives you the Amplitude or number of degrees that the Sun is from the East (if at his rising) or from the West at his setting; or if it be when the Sun is up, it gives the degree of the Compass that the Sun bears from you: so that by that, and knowing her height (which some body observes at the same time) you erect a Scheme for that purpose, and by it, or the Doctrine of Triangles, see the true Azimuth of the Sun at that height; and so much as that differs from this, so much is the *Variation*.

You may note, that when the Sun is above 45 degrees to the Southwards or Northwards of the East or West, that the Index must be placed accordingly; but I think him not wise, who observes when the Sun is so high. I will say no more of that, but if you should chance to take him so, remove your Index either to the North or South points, as you do to the East or West points; your own Reason will see it.

FINIS.

OF GUNNERY.

So much of that Art as is abſolutely neceſſary for a SEA-MAN to know.

CHAP. I.

I Intend not in this place to treat of the Art of *Gunnery* in general, for it would ſwell my Book to too great a Volume: But I ſhall onely touch upon ſuch parts thereof as every Sea-man (whether profeſſed Gunner or not) ought to be acquainted with, and (in caſe of neceſſity) be able to put in practice. And therefore in the firſt place (to avoid many words) I ſhall lay before you a Table ſhewing the Names, Weight, Length, *&c.* of ſuch Pieces of Ordnance as are now in Uſe. Which Table is thus to be read and underſtood:

As for Example: In the firſt Line of the Table, which is a Cannon Royal,

Whoſe
- Weight is 8000 pound.
- Length is 12 foot.
- Diameter at the Bore is 8 inches.
- Shots weight 63 pounds 4 ounces.
- Shots diameter is 7 inches and 67 hundred parts of an inch.
- Weight of Powder for load is 26 pound.
- Ladles length is 24 inches.
- Ladles breadth is 15 inches.
- Cartridges length is 16 inches, and 4 tenth parts of an inch.
- Cartridges breadth is 24 inches, and one tenth part of an inch.

A General TABLE *of the Names, Weights, &c.*

The Names Of the PIECES.	Weight of the Piece.	Length of the Piece.		Diamet. of the Bore.		Weight of the Shot.	
	Pounds.	F.	10	In.	100	Po.	O.
Cannon Royal.	8000	12	0	8	00	63	4
Cannon.	6800	12	0	7	00	42	6
Demi-Cannon.	5800	10	5	6	50	34	0
L. Demi-Cannon.	5400	11	5	6	25	30	3
First Culverin.	4800	11	0	5	50	20	8
Second Culverin.	4500	12	0	5	25	17	12
Third Culverin.	4000	11	0	5	00	15	4
First Demi-Culverin.	3000	11	0	4	75	13	3
Second Demi-Culverin.	2700	10	0	4	50	11	0
Third Demi-Culverin.	2000	9	5	4	25	9	2
First Saker.	1800	9	5	4	00	8	0
Second Saker.	1500	9	0	3	75	6	4
Third Saker.	1400	8	0	3	50	5	0
First Minnion.	1000	8	0	3	25	4	2
Second Minnion.	850	7	0	3	00	3	5
Faulcon.	750	7	0	2	75	2	10
Faulconet.	500	6	0	2	25	1	10
Rabinet.	300	5	0	1	50	0	6
Base.	200	4	0	1	25	0	4
Four Dutch PIECES.							
A 24 Pounder.	5000	11	0	5	79	24	0
A 12 Pounder.	3000	10	0	4	61	12	0
A 6 Pounder.	1500	9	0	3	70	6	0
A 3 Pounder.	750	7	0	2	94	3	0

of Pieces of Ordnance now in Use.

Diamet. of the Shot.		Weight of Powder.		Length of the Ladle.		Breadth of the Ladle.		Length of the Cartrid.		Breadth of the Cartrid.	
In.	100	P.	O.	In.	10	In.	10	In.	10	In.	10
7	67	26	0	24	0	15	0	16	4	24	1
6	70	18	10	23	5	12	5	17	1	21	1
6	23	15	4	23	0	11	5	16	2	19	6
6	0	13	6	20	0	11	8	15	4	18	9
5	25	9	3	16	5	10	0	13	5	16	5
5	0	7	13	15	0	9	0	12	8	15	7
4	76	7	4	14	5	8	7	12	9	15	0
4	52	6	8	14	0	8	6	13	5	14	2
4	27	5	10	12	6	8	5	12	5	13	4
4	2	5	3	12	0	8	0	13	0	12	6
3	84	4	8	11	0	7	2	12	2	11	1
3	53	3	10	10	6	6	7	11	7	10	1
3	28	3	0	9	8	6	5	11	2	10	3
3	10	2	6	9	0	5	6	9	9	9	7
2	85	2	0	8	4	5	0	10	0	9	9
2	62	1	8	8	0	4	6	8	7	8	2
2	10	1	0	7	0	4	0	8	7	6	6
1	40	0	6	6	0	2	6	7	2	4	7
1	18	0	4	4	5	2	2	6	3	3	7

Four Dutch PIECES.

5	56	10	8	18	0	11	0	14	0	17	4
4	40	6	0	14	0	9	0	12	7	18	8
3	49	3	8	10	6	6	5	11	7	11	0
2	77	1	10	9	0	5	5	8	6	8	7

CHAP. II.

The Names of ſuch Inſtruments as a Gunner of a Ship ought to be furniſhed with.

CAllapar Compaſſes large and ſmall, to take the diameters of the Rings of Guns, and the diameters of Shot.

A Height-Rule for diameters of Bores.

Braſs Heights for the nature of Shot.

A Gunners Scale.

A Gunners Quadrant.

Molds to caſt Leaden-bullets in of all ſizes.

Wyres and Springs for the Diſparting of Guns, with a Tranſome to go up and down, according to the diameter of the Gun. The Tranſome muſt be long enough to reach the Baſe-Ring from the Touch-hole.

A Plain Scale and Braſs Compaſſes with Steel points.

Other things are ſuch as no Sea-man is unprovided of.

CHAP. III.

How to ſearch a Great Gun *or* Piece *of* Ordnance; *that is, to diſcover whether there be any* Flaws, Cracks, *or* Honey-combs *(that is, irregularneſs) in any* Piece *of* Ordnance: *Several ways.*

The firſt way, for Flaws *or* Honey-combs.

IN a clear Sun-ſhine day, with a piece of *poliſhed Steel*, (or for want of that, a *Looking-glaſs* may ſerve) reflect the Beams of the Sun into the *Concave* of the *Piece*; by which means there will be ſuch a clear Light within the hollow *Cylinder* of the *Piece*, that any *Flaw* or *Honey-comb* may be eaſily diſcovered.

Another way.

Take a *Stick*, which muſt be ſomewhat longer than the *Concave* of the *Gun*, and making a ſlit at one end thereof, put an end of a *Candle* well lighted, into the *Notch*. Then put the *Stick* into the mouth of the *Piece*, and by the light of the *Candle*, turning the *Stick* every way, as you eaſily put it in or draw it out, and you ſhall pretty well diſcover *Flaws* or *Honey-combs*, if there be any in the *Piece*.

How to diſcover Cracks.

IMmediately after you have diſcharged a *Piece*, let one be ready with a *Tompkin* to clap into the *mouth* of the *Piece*, with a piece of *Rug*, *Blanket*, or a *Sheepskin* wrapped about the Muzzle of the Piece. Alſo, at the ſame time let one *ſtop* the *Touch-hole*; and if there be any *Crack* through the *Metal*, a viſible *Smoak* will appear.

Another

Another way to diſcover Cracks *or* Flaws.

If in ſtriking a *Piece of Artillery* a ſmart ſtroke with a *Hammer* on the out-ſide thereof, you ſhall hear a *hoarſe ſound*; it is an evident ſigne that the *Piece* is not ſound, but hath *Flaws*, *Cracks*, or *Honey-combs* about it. But if after every *ſtroke* with the *Hammer*, you hear a *cleer ſound*, it is an aſſured ſigne of a *ſound Gun.*

CHAP. IV.

How to find whether a Piece *of* Ordnance *be truly* Bored *or not.*

PRovide a *Pike-ſtaff*, longer than the hollow *Cylinder* of the *Gun*, by about 8 or 10 inches; at the end of which Staff faſten ſuch a Rammer-head (or rather a Piece of Wood turned on purpoſe) as ſhall juſtly fill the Concave-Cylinder under the Touch-hole; yet not to go in ſtiff, but eaſily. Then take another round piece of Wood made equal to the concavity of the *Muzzle* of the Piece; in the center whereof make a hole, that the long Staff may go through, and fix this round piece of Wood upon the Staff, in that part that reaches to the Pieces mouth, then at the end of the Staff, which is without the Piece, make a ſmall hole acroſs, through the middle of the Staff, to faſten therein a ſmall Rod of Iron about 14 or 15 inches long; at the end of which Iron Rod, fix a *Bullet* of about 7 or 8 pound weight: And ſo is your Inſtrument fitted.

This Inſtrument thus prepared, put the *Rammer-head* into the *Mouth* of the *Piece*, home to the end, and then put the round piece of Wood into the Mouth of the Piece, and then (the Concave of the Piece lying level in the Carriage) the *Bullet* at the end of the *Staff* will keep both the *Rammer-head* and the *round piece of Wood* in a ſetled poſture. Then take your *Priming-Iron* and put it in at the *Touch-hole*, and make a mark with it upon the *Rammer-head*: This done, draw out the *Inſtrument*, and lay the *Rammer-head* and *round piece of Wood* upon a long and level *Table*, the end of the *Staff* where the *Bullet* hangs, being off of the *Table*, ſo ſhall the weight of the *Bullet* cauſe the *Rammer-head* and

and *round piece of Wood* to lie in the ſame poſition upon the *Table*, as they did when they were in the *Cylinder* of the *Gun*.

The Inſtrument lying ſtill upon the Table, obſerve whether the *mark* you made upon the *Rammer-head*, when it was in the *Piece*, be juſt on the uppermoſt part of the ſame, as it now lies on the Table; if it be, the *Boar* of the *Piece* lieth neither to the right nor left hand; but if you find the mark not to be at the top, but inclining either to the right or left hand, ſo much doth the *Bore* of the *Piece* lie to the right or left hand: And therefore in Shooting, the *Piece* muſt be charged and ordered accordingly.

By what hath been here delivered, you may find whether the *Bore* incline to the *right* or *left* hand. But to know whether it lie upwards or downwards, and not in the middle, that way is not ſufficient; therefore, to find that, take the Directions following.

Take a piece of ſtreight Wire, and bend it a little at one end, about a quarter of an inch or leſs, that it may catch at the *Metal* when you take it out at the *Touch-hole*. Your *Wyre* being prepared, put it in at the *Touch-hole*, till it touch the *Metal* in the bottom of the *Chamber*, and make a mark upon the Wyre, juſt even with the ſaid *Touch-hole*; then draw up the *Wyre* till the Hook catch at the *Metal* at the top of the *Chamber*, and there make a *mark* as before: The diſtance of theſe two *marks*, is the juſt diameter of the Chamber; and the diſtance between the firſt *mark* and the end of the *Wyre*, (half the diameter of the *Chamber* being taken out of it) will be half the diameter of the Piece at the *Touch-hole*, if the Piece be truely bored: But if this number be greater than half the *diameter* of the *Piece*, then the *Bore* lieth too far from the *Touch-hole*, and the upper part of the *Metal* is the *thickeſt*; but if the number be *leſſer* than half the *diameter*, the *under* part of the *Metal* is the *thickeſt*.

EXAMPLE.

We will ſuppoſe the *diameter* there to be 12 inches; then by my *Wyre* I find the *diameter* of the *Bore* to be 4 inches, and to the bottom of the *Metal* 7 inches and a half: The half of the *diameter* of the *Bore* is 2 inches, which being ſubſtracted from 7 inches, leaves 5 inches and a half; which is leſs than half the *diameter* of the *Piece* at the *Touch-hole*, by half an inch; and therefore the *greateſt* part of the *Metal* is in the *bottom* (or under the Bore) of the Piece: Wherefore the danger of the Pieces *breaking* is above.

CHAP.

CHAP. V.

How to find the length of the Diſpart, *belonging to any true Bored* Piece *of* Ordnance.

FOr the effecting of this, there are ſeveral ways, of which ſome are more artificial than others: I will give you an account of ſeveral of them, and give the induſtrious *Gunner* leave to make choice of that which may beſt ſuit with the time and place where he hath occaſion to make uſe of it.

One way.

Girt the Piece round about the *Baſe-Ring*, and alſo about the *Muzzle-Ring*, ſeverally, with a String, (or rather with a piece of *Tape*, or narrow *Ribond*, which will not ſtretch.) Find or meaſure the lengths of theſe two Girts ſeverally upon ſome Scale of equal parts, (as of Inches, and 100 parts of an inch) then divide each of theſe *Girts* into 22 equal parts, and with your Compaſſes take 7 of them; ſo ſhall 7 of the greater *Girt* be equal to the *diameter* of the *Gun* at the *Baſe-Ring*; and 7 parts of 22 of the leſſer *Girt*, ſhall be the *diameter* of the *Piece* at the *Muzzle-Ring*: Then with your Compaſſes meaſure the lengths of each of theſe Diameters, in inches and hundred parts of an inch; and ſubſtract the leſſer of them from the greater, and half of the remainder ſhall be the *length* of the *Diſpart* belonging to that *Piece*.

EXAMPLE.

Coming to a Gun whoſe *Diſpart* I would know; firſt, I girt the *Baſe-Ring*, and find it to be 42 inches about; then I girt the *Muzzle-Ring*, and find that to be 31 inches about; then dividing the length of the *greater Girt* 42, into 22 equal parts, I find 7 of them to contain 13 inches, and 37 hundred parts of an inch, (which is above a quarter of an inch.) Set this number by; for it is the length of the *diameter* of the *Baſe-Ring*. Then divide the length of the *leſſer Girt* 31, into 22 equal parts, and 7 of them will contain 9 inches, and

86 hundred parts of an inch, (which is above three quarters of an inch.) Set this number by alſo, for it is the length of the diameter of the *Muzzle-Ring*, and ſubſtract it from the former, and the remainder (or difference) will be 4 inches 50 hundred parts of an inch (which is 3 inches and a half;) the half of which is 1. 75; that is, 1 inch, and 75 hundred parts of an inch, which is 1 inch and 3 quarters; for the true length of the *Diſpart* for ſuch a *Gun*, whoſe *Girt* at the *Baſe-Ring* is 42 inches, and at the *Muzzle-Ring* 31 inches.

This is a good way to *Diſpart* any Gun; but it is very tedious, and requires great care in the performance. Wherefore take

A ſecond way to Diſpart *any* Gun.

Take two ſmall *Sticks*, (each of them muſt be longer than the diameter of the *Baſe-Ring* of the Piece you would diſpart;) lay one of theſe Sticks (the middle of it) upon the upper-part of the *Baſe-Ring*, (ſquarewiſe croſs the Piece) and fixing it (or cauſing one to hold it faſt) there, having in readineſs a fine Thread and Plummet, hold it up by the ſide of the Stick, moving it along till the String do juſtly touch the *Baſe-Ring* on one ſide of the Piece, and when it doth ſo, make a ſmall mark upon the Stick; then take your Thread and Plummet, and go to the other ſide of your Gun, and hold it up as before, till the Thread touch the other ſide of the *Baſe-Ring*; and when it doth ſo, make another mark on the Stick: Then cut the Stick off (ſquare-wiſe) at theſe two marks, for the length of it is equal to the *diameter* of the *Baſe-Ring* of the Piece. Do the like (with your other Stick) at the *Muzzle-Ring*; and laying theſe two Sticks together, you ſhall find the difference of their lengths: and half that difference is the true *Diſpart* for that *Piece*.

This alſo is a good way, but it muſt be neatly handled; otherways you may run into a great Errour.

A third way to Diſpart *any* Piece.

If the Piece be not *Chamber-bored*, take your *Priming-Iron*, or a ſtreight ſmall *Stick* or *Wyre*, and put it down into the *Touch-hole*, until it ſtop at the Metal under the *Touch-hole* in the bottom; and upon the *Stick* or *Wyre*, make a mark level with the top of the *Baſe-Ring*; apply the ſame Stick or Wyre to the bottom of the *Metal* at the *Mouth* of the *Piece*: And ſo much higher as the mark at the *Baſe-Ring* was, more than this at the *Muzzle-Ring*, that difference is the true *Diſpart*.

CHAP. VI.

Conſiſting of ſeveral Queſtions, which every Gunner ought to be perfect in, and ſo able to reſolve them upon any demand.

QUEST. 1.

The Diameter and Weight of a Shot being given, to find the Weight of any other Shot of the ſame Metal, and of any other Diameter.

Examp. *I have an Iron-Shot which is four inches diameter, and it weighs* 8 *pound; I have another Shot of Iron whoſe diameter is* 8 *inches: I demand what is the weight thereof?*

The Analogie or Proportion.

As the Cube of the Diameter of the given Bullet,
Is to his Weight;
So is the Cube of the other Bullets Diameter,
To his Weight.

FOr the doing this, cube both the Diameters, and the Analogie is both plain and eaſie: for,

As the Cube of the Diameter of the given Shot,
Is to the weight of the ſame;
So is the Cube of the Diameter of the Shot whoſe weight is required,
To his weight.

4 inches	8 inches
4	8
16	64
4	8
64 cube	512 cube

If

If 64 (the Cube of the Shot given) weigh 9 pound, what shall the Shot weigh, whose Cube of Diameter is 512?

64 9 512
9
4608

Facit 72 pound

x
42(0
4808(72
644
6

QUEST. 2.

The Weight and Diameter of a Shot given, to find the Diameter of another Shot by his weight given, they both being of one Metal.

Examp. *Admit a Shot be* 27 l. *and his Diameter be* 6 *inches; what shall a Shot of* 64 l. *have for his Diameter?*

EXtract the Cube-root of 64, and its 4; and the Analogie is as here following.

As the Root of 27, which is 3,
Is to the Diameter 6;
So is the Root of 64, which is 4,
To the Diameter required.

24(8
3

4
6
24

Facit 8 inches diameter.

QUEST. 3.

Having the Content and Diameter of a Shot given, to find the Content or Weight of any other Shot, whose Diameter is given.

Examp. *Admit I have a Shot whose Diameter is* 4 *inches* $\frac{1}{4}$, *and his weight is* 10 l. 12 oun. *I demand the Content of that Shot that is* 6 *inches diameter?*

NOte, 4 inches $\frac{1}{4}$ is 4, $\frac{25}{100}$; and becaufe the firft and third number is both to be reduced to one denomination, before it can be wrought by the Rule of Proportion; therefore the 6 inches is 6 $\frac{00}{100}$ Alfo, reduce your middle number, which is 10 *l.* 12 *oun.* into ounces, and it is 172 ounces. Cube the Diameters, and fay,

As the Cube of 4, 25,
Is to 172 ounces;
So is the Cube of 6, 00,
To the Content or Weight of the Shot required.

And ſo working of it, you will have the Reſult in ounces, becauſe the middle number was reduc'd into ounces; which divide by 16, and the Quotient is pounds, the remainder of the diviſion ounces.

QUEST. 4.

The Diameter of a Shot being given, to find the Circumference in the higheſt part of it.

Examp. *Let there be a Shot that is* $6, \frac{20}{100}$ *inches Diameter; I demand the Circumference?*

The Analogie.

As 7, is to 22; ſo is the Diameter of any Shot, to his Circumference.

Example.

If 7	22	6, 20	
		22	
		12, 40	
Facit 19, $\frac{48}{100}$ inches		1240	
Circumference		136, 40	

QUEST. 5.

The Circumference of a Shot given, to find the Diameter.

Examp. *Let a Shot be* 19, 48 *inches about; I demand the Diameter?*

This is but the converſe of the former Caſe: for,

As 22, is to 7; ſo is the Circumference of any Circle, to the Diameter. Therefore,

As 22	7	19, 48	
		7	
Facit 6 $\frac{194}{1000}$ inches of a hundred		13636	

QUEST.

QUEST. 6.

To find the ſuperficial Content of any Circle or Bullet that is cleft (as it were) in the middle.

The General Analogie or Rule.

As 14, is to 11; ſo is the ſquare of the Diameter of any Circle, to the ſuperficial Content.

QUEST. 7.

To find the ſollid Content of any round Shot, and ſo his Weight.

The Analogie is,

As 21, is to 11; ſo is the Cube of the Diameter of any Globe or round Bullet, to the ſollid Content of the ſame.

Examp. *Admit I have a Shot that is 6 inches Diameter; I deſire to know his Content in inches?*

If 21	11	216			6
		11			6
		216			36
		216			6
		2376		Diameters Cube	216

Facit 113 $\frac{1}{7}$

Next, to know the Weight of this Shot which we ſuppoſe to be Iron.

Note, That one inch ſollid of Iron weighs 4 ounces; therefore I'll multiply the Content in inches by 4, and it gives the Content in ounces.

		113, 1
		4
	Content in ounces	452, 4

Facit 28 4 ounces, $\frac{4}{7}$ of one ounce.

QUEST.

QUEST. 8.

To find the ſollid Content of the Vacuity or Concave-Cylinder of a Gun.

TAke the Diameter of the Guns Bore, and find the ſuperficial Content of that Circle, (as I have ſhewed in *Queſt.* 6.) then take the depth of the Bore, and multiply it by that ſuperficial Content, and you have your deſire. (This is if the Gun be full bored.)

QUEST. 9.

The Weight of a Gun being given, to find the Weight of another Gun that is of the ſame make, but thicker or thinner metled.

TAke the greateſt Diameter of the given Gun, and alſo of the unknown Gun, and cube both their Diameters; then ſay,

As the Cube of the Diameter of the known Gun,
Is to his Weight;
So is the Cube of the Diameter of the unknown Gun,
To his Weight required.

QUEST. 10.

To find the Weight of any Iron Gun that is ſound, without weighing him (very near.)

TAke the height of the Gun at the Britch, and alſo at the Muzzle; then take his length, and find his content in inches, as though he were all ſolid. This done, find the Content of the Concave, and ſubſtract that from the other, and note the remainder. Then find the Content of the Nuts or Trunnions (which are *Cylindrical*) and give a competent allowance for the Rings and Britch (without the utmoſt height) and adde them to the remainder; the ſum is the Guns Content in inches.

Now becauſe one ſolid inch of Metal is 4 ounces, multiply the Content in inches by 4, and it gives the Content in ounces; and divide them by 16, and the Quotient is the Content in pounds; the remainder of the Diviſion is ounces (becauſe 16 ounces is one pound.)

QUEST.

QUEST. 11.

What allowances of Powder muſt be given for any Gun.

A Braſs Gun of about 4000 *l.* weight, you may allow three ounces of Powder to every 112 *l.* of Metal in ſervice.

To a fortified Gun of Braſs, that's a Culverin of about 4000 *l.* weight, and to uſe him in ſervice, allow about half the weight of the Shot for his load of Powder, becauſe of his heating.

For a Saker, four fifths of the Shots weight is his load for Action; but for ſmaller Pieces, the whole weight of their Shot is their load; but you may abate ſuitable to your diſcretion, when they are hot, according to the ſtrength and goodneſs of the Powder.

¶ Note, *Three quarters as much Powder is the load for an Iron Gun, as is for a Gun of the ſame nature of Braſs.*

To a Demi-Gannon, the *Tower* allows 5 ounces and half of Powder to every 112 *l.* of Metal, if the Gun be a fortified Piece of about 4400; but in ſervice ſcarce 4 ounces to every 112 *l.* of Metal (if the Gun be Braſs.)

Demi-Gannon Drake, of about 3800 *l.* weight of Iron, allow in ſervice 3 ounces to 112 *l.* of Metal.

Demi-Culverin Braſs, of 3300 *l.* in ſervice, allow 3 ounces to every 112 *l.* of Metal.

Twelve Pounders of Braſs, fortified, 3200 weight, 3 ounces and half to every 112 *l.* of Metal.

CHAP. VII.

Of FIRE-WORKS.

How to fit a Granado-ſhell for Execution.

IN the Orifice of the Shell put in a piece of wood that hath a hole through it, and in that hole put your Fuſe, ſo that it may joyn to the Powder which before is put into the Shell, (at the hole the Stick or Fuſe

Fuſe is put in at;) Set this Stick well into the Shell that it may be ſure to reach the Powder, and let the top be broad and hollow to entertain the Fuſe. Men do commonly fill the void place with grownd Powder, which muſt be moiſtened with Gum-water or diſſolved Glue, that it may joyn the better. I ſuppoſe your own ingenuity will direct you how to compoſe the Fuſes, and therefore I omit writing of it, but fill the Concave with Powder the ſtrongeſt.

To make Stink-Balls.

TAke Powder 10 *l.* of Ship-Pitch 6 *l.* of Tar 20 *l.* Salt Peter 8 *l.* Sulphur Califonia 4 *l.* Melt theſe by a ſoft heat together; and being well melted, put 2 *l.* of Cole-duſt, of the Filings of Horſes Hoofs 6 *l.* Aſſa Fœtita 3 *l.* Sagapenem 1 *l.* Spatula Fœtida half a pound: Incorporate them well together, and put into this matter Linnen or Woollen-Cloath, or Hemp or Toe, as much as will drink up all the matter: and of theſe make Globes or Balls of what bigneſs you pleaſe. This Globe or Ball may be made venomous or poyſonous, if to the Compoſition be added theſe things following: Mercury Suplimate, Arſnick, Orpiment, Sinaber, *&c.*

To make Powder-Pots.

THey are commonly made of black Potters Clay, or thick Glaſs round Bottles with Ears to tye Matches lighted at both ends: Fill them with dry fine Powder, and thrown upon the Deck or otherwhere, they prove often prejudicial to the Enemy, and ſometimes fire their own Powder-cheſts.

Thus much tending to a Sea-Gunner. I thought it might not be improper to this Book, becauſe Maſters Mates are ſometimes Gunners too; and all ought to know theſe things that go to Sea.

THE

THE
Use of the Tables
OF
Logarithms.

I. *Any Number under* 10000 *being given, to find the* Logarithm *thereof.*

A Description of the Table of ten *Chiliads.*

THE Left-Hand Colume of every page contains numbers increasing in their natural Order from 1 to 999. The other five Columes of each page contain the *Logarithms* of all Numbers from 1 to 9999. The five Columes on the Left-Hand Page have at the tops of them these Figures (larger than the rest) 0, 1, 2, 3, 4. Those on the Right-Hand Page, these, 5, 6, 7, 8, 9. And the Numbers in the first Colume of each Page towards the Left-Hand, by the supply of those Figures on the tops of the other five Columes, will extend those Numbers to 9999, and are so to be read. All this will be plain by the Examples following.

Example 1. *A Number consisting of One Figure being given, to find the* Logarithme *thereof.*

At the top of the ten Columes of the two first Pages of the *Tables* are the Figures 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and the Numbers under them are their *Logarithms*: So the *Logarith.* of 4 is 0.6020600; which

is the Number ſtanding under 4, and the reſt as here is expreſſed, *Viz.*

	Numb.	*Logar.*		*Numb.*	*Logar.*
The *Logarithm* of	1	0.0000000	The *Logar.* of	5	0.6989700
	2 is	0.3010300		6	0.7781512
	3	0.4771212		7 is	0.8450980
	4	0.6020600		8	0.9030909
				9	0.9542425

Example 2. *A Number conſiſting of two Figures, to find the Logarithme thereof.*

Let it be required to find the *Logarithme* of 73. Look for 7 (the firſt Figure of the given Number) in the firſt *Colume* of the firſt Page of the *Table*, and 3 (the other Figure) in the top; and againſt 7 in the ſide, and under 3 in the top, is this Number 1.7993405; which is the *Logarithme* of 73. And thus you ſhall find that,

	Numb.	*Logar.*
The *Logarithme* of	42	1.6232493
	68 is	1.8325089
	89	1.9493909 *&c.*

Example 3. *A Number conſiſting of three Figures, to find the Logarithme thereof.*

Let it be required to find the *Logarithme* of 476. Look for the firſt two Figures of the given Number (*Viz.* 47) in the firſt *Colume* of the *Table*, and the third Figure (*Viz.* 6) at the top: And then, againſt 47, and under 6, is this Number 2.6776069; which is the *Logarithme* of 476. And ſo,

	Numb.	*Logar.*
The *Logarithme* of	241	2.3820170
	480 is	2.6812412
	838	2.9232440 *&c.*

Example

Example 4. *A Number consisting of four Places, being given, to find the Logarithme thereof.*

Let the *Logarithme* of 5683 be required. Look for the three first Figures, (*Viz.* 568) in the first *Colume* of the *Tables*, and the last Figure (*Viz.* 3) at the top: And then against 568 (in the same line) and under 3 you shall find this Number, 3.7545777, which is the *Logarithme* of 5683. And so,

	Numb.	*Logar.*
The *Logarithme* of	2372	3.3751147
	4070 is	3.6095944
	6904	3.8391008 *&c.*

And thus much for the finding of the *Logarithme* of any Number given, not exceeding four Places. It remains now that I shew you how;

II. *Any* Logarithme *being given, to find the Absolute Number thereunto belonging.*

YOu are here to Note, That if the first Figure to the Left-Hand of the *Logarithme* given (which is separate from the rest by a *Point* or *Comma*,)

Be { 0, 1, 2, 3 } Then the Absolute Number answering to that *Logarithme*, consists of { 1, 2, 3, 4 } Places

This by the way of Caution: Now for Examples.

Example 1. *Let* 0.8450980 *be a Logarithme given, and the Absolute Number answering thereunto be required.*

By the Rule above, the first Figure being 0 (or a *Cypher*) signifies that the Number answering thereunto consisteth but of one Figure, and therefore will be found in the first Line of the first two Pages of the *Tables*; so looking along that line, you shall find this *Logarithme* to stand under the Figure 7, which is the Absolute Number answering to that *Logarithme*.

Example 2. *Let the* Logarithme *be* 1.6232493, *and the Absolute Number belonging to it be required.*

By the first Figure being 1, it appears that the Number sought must consist of two Figures, and consequently will be found in the 9 first lines of the two first Pages of the *Tables*; wherefore look there for the first Number, which begins with 6 after the 1, and that you shall find to stand against 4, then cast your Eye, or carry your Finger along that line till you find the given *Logarithme*; and so doing, you shall find your given Number to stand under 2, which joyned with the 4 in the first *Colume*, makes 42 for the absolute Number belonging to the given *Logarithme*, 1.6232493. And thus you may find the Number answering to any *Logarithme* of two places in these first 9 lines. And so,

	Logar.	*Numb.*	
The absolute Number answering to this *Logarithme.*	1.8325089	68	
	1.5832764	is 38	nearest.
	1.9493900	89	*&c.*

Example 3. *Let this Logarithme* 2.3873898 *be given, and its Absolute Number be required.*

It appears that the Number required will consist of 3 Places: Wherefore look in the *Table* of *Logarithmes*, in the *Colume* that hath 0 at the top (which is the second *Colume*) till you find your *Logarithme* given

given (or the neareſt thereunto being leſs) and you ſhall find 2.3802112 to ſtand againſt 24, then caſt your Eye along that line till you find a *Logarithme* nearer to your *Logarithme* given, and in the ſame line you ſhall find your *Logarithme* in the *Colume* that hath 4 at the top; which 4 being added to the 24 in the firſt *Colume*, makes 244; which is the *Abſolute Number* anſwering to the *Logarithme* 2.3873898. And ſo,

	Logar.	*Numb.*
The *Abſolute Number* anſwering to this *Logarithme.*	2.1003705	126
	2.4683712 is	294 neareſt.
	2.8712004	743 neareſt.

Example 4. *Let this* Logarithme 3.3751147 *be given, and let the Abſolute Number belonging thereunto be required.*

It appears that the *Number* ſought will conſiſt of 4 Figures, therefore look in the *Colume* that hath 0 at the top, till you find your given *Logarithme* (or the neareſt to it) and you ſhall find 3.3747483 to ſtand againſt 237; then caſting your Eye along that line, you ſhall find your given *Logarithme* in that *Colume* that hath 2 at the Head of it; which 2 being adjoyned to the 237, makes 2372 for the *Abſolute Number* anſwering to the given *Logarithme* 3.3751147. And ſo

	Logar.	*Numb.*
The *Abſolute Number* anſwering to this *Logarithme.*	3.8580557	7212
	3.5210860 is	3319 neareſt.
	3.2816403	1913 neareſt.

If you cannot find the direct *Logarithme* you look for in the *Table*, you muſt take the neareſt thereunto. As by the Examples above you may ſee is done.

From

From hence then 'tis evident, that it is but the changing the *Caracture* (or first Figure to the Left-Hand) of any *Logarithme*, and you may take the *Logarithme* off a Number to the $\frac{1}{10}$ part, or the $\frac{1}{100}$ part of a *Unit*; for here the *Caracture* of 59 was 1.7708528, and the *Caracture* of 59.0, which may be $59\frac{0}{10}$, is 2.7708528; which is the same as the other, excepting the *Caracture*, or first Figure towards the Left-Hand; or if you take 59.00, which may be $59\frac{00}{100}$, the *Logerithme* answering to 5900 is 3.7708528. And thus you may take the *Logarithme* of a Number with a *Fraction* annexed.

Example 5. *To find the* Logarithme *with a* Decimal Fraction *annexed.*

Admit I would know the exact *Logarithme* of $38\frac{2}{10}$. I'll set it down as a whole Number 382, and so look for the *Logarithme* of it, and it is 2.5820634. I say then this is the *Logarithme* to 382, or $38\frac{2}{10}$. The like for any other.

Example 6. *To find the* Logarithme *of a Whole Number with a Vulgar Fraction annexed.*

Let the Number be $31\frac{2}{7}$, I desire to know the exact *Logarithme* of it: I'll reduce my *Whole Number* and *Fraction* into an *Improper Fraction*, by multiplying the *Whole Number* by 7, and it makes $\frac{217}{7}$, to which I add the $\frac{2}{7}$, and the *Total* is $\frac{219}{7}$: This done, Substract the *Logarithme* of the *Denominator* of the *Improper Fraction* from the *Logarithme* of the *Numerator* of the same, and the *Remainder* is the *Logarithme* of the *Whole Number* and *Fraction.*

Example.

The *Numerator* ——	222 ——	2.3463530
The *Denominator* ——	—7 ——	0.8450980
The *Logarithme* of $31\frac{2}{7}$ is ——		1.5012550

Thus much for the Use of the *Table* of *Logarithmes.*

THE

THE

Use of the Tables

OF

Sines & Tangents

AT the top of each Page of the *Tables* are set in large Figures the Number of each Degree of the *Quadrant*, thus, 1 Grad. Signifying 1 Deg. *&c.* going to 45 Grad. And in the first *Colume* to the Left-Hand, is the *Minutes* from 0 to 30', having M at the top, and beginning on the next Page at 30', and so down to 60 *Minutes* : and so they go forward to 45 deg. And under every *Degree*, and against every *Minute*, is marked *Sine* : *Sine*, *Complement* : *Tangent*; and *Tangent*, *Complement*. And from 45 *Degrees* the *Tables* run backwards (with the *Degrees* below in larger Figures) to 90 *deg.* the *Minutes* upwards having M under them, signifying *Minutes* : And under the *Columes* below is also written, *Tangent* : *Tangent*, *Complement* : *Sine* : *Sine*, *Complement*.

Example 1. *How to find the* Sine *or* Targent *of any* Degree *and* Minute.

Look against the *Minute* of that *Degree* under *Sine*, and you have your Desire : If your *Degrees* and *Minutes* be under 45, look for it from the *Sine* or *Tangent* named at the top of the *Table*; if more than 45 *Degrees* from the *Sine* or *Tangent*, named at the bottom : As,

The *Sine* of 22 *deg.* 20′ is —— 9.579777 —— above.
The *Tangent* of 22° 20′ is —— 9.6136407.

If you were to take the *Sine Complement* of 22° 20′, or the *Tangent Complement*, take it ſo under *Sine Complement*; or for a *Tangent Complement*, under *Tangent Complement*.

But if you were to take the *Sine* or *Tangent* of 56° 15′, or any other above 45°, take it from below: ſo the *Sine* of 56° 15′ is 9.9198464, the *Tangent* of it is 10.1751074, the *Sine Complement* of it is 9.7447390, the *Tangent Complement* of it is 9.8248926.

If you would find the *Degree* and *Minute* anſwering to any *Logarithmatical Sine* or *Tangent*, look for the neareſt to it, and againſt it is the *Minute*, and over them the *Degree*, if under 45°; or if it exceed 45°, you will find the *Minute* againſt it to the Right-Hand, and the *Degree* below, thus,

This *Logarithmatical Sine* —— 9.4704548 —— is —— 17° 11′
This *Logarithmatical Tangent* — 9.4902858 —— is —— 17° 11′

Or Below,

This *Sines Logarith.* ———— 9.9678763 —— is —— 68° 14′
This *Tangents Logarith.* ——— 10.3987042 —— is —— 68° 14′

I have ſhewed how to take a *Complement Arithmetical* already, but leaſt you ſhould not meet with it, I have here done it.

Whatſoever the *Logarithme* of any *Sine* wants (the ſingle Figures one by one) of 9, take, inſtead of the Figures themſelves; Thus,

The *Logarithme*, if 56° 15′, —— is —— 9.9198464.
The *Complement Arithmetical* — is —— 0.0801535.

The

The like of a *Sine Complements Logarithme.*

The *Complement Arithmetical* of a *Tangent*, or *Tangent Complement*, is the *Tangent Complement* of that *Tangent*, or the *Tangent* of that *Tangent Complement:* Thus,

The *Complement Arithmetical* of 4, 56, 15 is 9.8411871.
The *Compl. Arith.* of *Tang. Compl.* 56° 15′ is 10.1588128.
The like of any other.

To find the Arch answering to any Artificial Sine *or* Tangent.

Suppose I have this *Artificial Sine* 9.5403719, and the *Arch* be required that this is the *Sine* of.

I look in the *Colume* of *Sines*, and find not exactly the same, but the neareſt greater than it is. —— 9.5405903
I look and find the neareſt leſſer to be —— 9.5402489

I Subſtract theſe one from the other, & the *diff.* is-0.0003414

Alſo I'll Subſtract the leaſt from the *Sine* given 9.5403719
9.5403489

And the *Remainder* is —— 230

I'll ſay now by the *Rule of Proportion.*

As the greater difference —— 3414
Is to the leſſer difference —— 0230
So is 60 *Seconds*, that is 1′ to a fourth Number.

3414) 13800 (4 *Quotient.*

13656

144 *Remainder.*

Facit 11″ and ſomething more.

Then I conclude, That the *Arch* anſwering to the *Sine given*, is more than the neareſt, leſs than it (which is 20° 18′) by 4 *Seconds*: So that the true *Arch* to that *Sine* is (leſs than a *Second*) 20° 18′ 4 *Sec.* The like is to be underſtood of a *Tangent*, &c.

To find the Artificial Sine *or* Tangent *anſwering to any Arch given.*

Suppoſe the Arch given be 31° 10′ 11 *ſec.* I demand the *Sine* anſwering this *Arch.*

I look in the *Tables*, and find the *Sine* anſwering to 31° 10′ is 9.7139349 : the *Sine* anſwering to 31° 11′ is 9.7141437 : the difference of theſe is 2088 (for but 1′ of a *deg.* or 60 *ſec.*) I ſay then,

As 60 *ſec.* is to 11 *ſec.*
So is the diff. 2088 to a fourth Number.

Which I find to be 382 : this add to the leſſer *Logarithme* of the *Sine* 9.7139349, and it makes 9.7139731, the *Sine* anſwering to the *Arch* 31° 20′ 11 *ſec.*

And the Reaſon is evident; for (as my Father Mr. *Richard Norwood* ſaith,)

As the difference of any next two *Logarithmes*
Is to any part of that difference;
So is the difference of the two Numbers to which they belong,
To the Proportional part of that difference, and the contrary.

Theſe

These Things I promiſed (in ſeveral places of this Book) to write of; that ſo the Learner may be able to work any thing (that requires ſuch exactneſs) to a *Second*; that is, to the *60th.* part of one *Minute* of a Degree, or the *60th.* part of one *Minute* of Time; or to the 100 part of a Mile or Foot, *&c.*

A Table

A

TABLE

CONTAINING

Ten Chiliads

OF

Logarithmes,

FOR

Numbers increasing in their Natural Order, from 1 to 1000.

LONDON,

Printed by *John Gain*, 1685.

N	0	1	2	3	4
0	0 0000000	0 0000000	0 3010300	0 4771212	0 6020600
1	1 0000000	1 0413927	1 0791812	1 1139433	1 1461280
2	1 3010300	1 3222193	1 3424227	1 3617278	1 3802112
3	1 4771212	1 4913617	1 5051500	1 5185139	1 5314789
4	1 6000600	1 6127838	1 6232493	1 6334684	1 6434527
5	1 6989700	1 7075702	1 7160033	1 7242759	1 7323937
6	1 7781512	1 7853298	1 7923917	1 7993405	1 8061800
7	1 8450980	1 8512583	1 8573325	1 8633228	1 8692317
8	1 9030900	1 9084850	1 9138138	1 9190781	1 9242793
9	1 9542425	1 9590414	1 9637878	1 9684829	1 9731278
10	2 0000000	2 0043214	2 0086002	2 0128372	2 0170333
11	2 0413927	2 0453230	2 0492180	2 0530784	2 0569048
12	2 0791812	2 0827854	2 0863598	2 0899051	2 0934217
13	1139433	1172713	1205739	1238516	1271048
14	1461280	1492191	1522883	1553360	1583625
15	1760912	1789769	1818436	1846914	1875207
16	2041200	2068259	2095150	2121876	2148438
17	2304489	2329961	2355284	2380461	2405492
18	2 2552725	2 2576785	2 2600714	2 2624511	2 2648178
19	2787536	2810333	2833012	2855573	2878017
20	3010300	3031960	3053513	3074960	3096301
21	3222193	3242824	3263358	3283796	3304138
22	3424227	3443923	3463530	3483048	3502480
23	3617278	3636120	3654880	3673559	3692158
24	2 3802112	2 3820170	2 3838153	2 3856063	2 3873898
25	3979400	3996737	4014005	4031205	4048337
26	4149733	4166405	4183013	4199557	4216039
27	4313637	4329693	4345689	4361626	4377505
28	4471580	4487063	4502491	4517864	4533183
29	4623980	4638530	4653828	4668676	4683473
30	2 4771212	2 4785665	2 4800069	2 4814426	2 4828736
31	4913617	4927604	4941546	4955443	4969296
32	5051500	5065090	5078559	5092025	5105450
33	5185139	5198280	5211381	5224442	5237464
34	5314789	5327544	5340261	5352941	5365584
35	5440680	5453071	5465426	5477747	5490033
36	5563025	5575072	5587086	5599066	5611014

N.	5	6	7	8	9
0	0 6989700	0 7781510	0 8450980	0 9030900	0 9542425
1	1 1760912	1 2041200	1 2304489	1 2552725	1 2787536
2	1 3979400	1 4149733	1 4313637	1 4471580	1 4623980
3	1 5440680	1 5563025	1 5682017	1 5797836	1 5910646
4	1 6532125	1 6627578	1 6720978	1 6812412	1 6901961
5	1 7403627	1 7481880	1 7558748	1 6734280	1 7708520
6	1 8129133	1 8195439	1 8260748	1 8325089	1 8388491
7	1 8750612	1 8808136	1 8864907	1 8920946	1 8976271
8	1 9294189	1 9344984	1 9395192	1 9444827	1 9493900
9	1 9777236	1 9822712	1 9867717	1 9912261	1 9956352
10	2 0211893	2 0253058	2 0293838	2 0334237	2 0374265
11	2 0606978	2 0644580	2 0681858	2 0718820	2 0755469
12	2 0969100	2 1003705	2 1038037	2 1072099	2 1105897
13	1303337	1335389	1367205	1398791	1430148
14	1613680	1643528	1673173	1702617	1731862
15	1903317	1931246	1958996	1986571	2013971
16	2174839	2201081	2227165	2253093	2278867
17	2430380	2455127	2479732	2504200	2528530
18	2 2671717	2 2695129	2 2718416	2 2741578	2 2764618
19	2900346	2922561	2944662	2966652	2988531
20	3117538	3138672	3159703	3180633	3201463
21	3324384	3344537	3364597	3384565	3404451
22	3521825	3541084	3560258	3579348	3598355
23	3710678	3729120	3747483	3765770	3783979
24	2 3891661	2 3909351	2 3926969	2 3944517	2 3961993
25	4065402	4082399	4099331	4116197	4132997
26	4232459	4248816	4265112	4281348	4297523
27	4393327	4409091	4424797	4440448	4456042
28	4548448	4563660	4578819	4593925	4608978
29	4698220	4712917	4727564	4742162	4756712
30	2 4842998	2 4857214	2 4871384	2 4885507	2 4899585
31	4983105	4996871	5010593	5024271	5037907
32	5118834	5132176	5145477	5158738	5171959
33	5250448	5263393	5276299	5289167	5301997
34	5378191	5390761	5403295	5415792	5428254
35	5502283	5514500	5526682	5538830	5550944
36	5622929	5634811	5646661	5658478	5670261

N	0	1	2	3	4
37	2 5682017	2 5693739	2 5705429	2 5717088	2 5728716
38	5797836	5809250	5820634	5831988	5843312
39	5910646	5921767	5932861	5943925	5954962
40	6020600	6031444	6042266	6053050	6063813
41	6127838	6138418	6148972	6159500	6170003
42	6232493	6242821	6253124	6263403	6273658
43	2 6334684	2 6344773	2 6354837	2 6364879	2 6374897
44	6434527	6444386	6445223	6454037	6473830
45	6532125	6541765	6551384	6560982	6570558
46	6627578	6637009	6646420	6655810	6665180
47	6720978	6730209	6739420	6748611	6757783
48	6812412	6821451	6830470	6839471	6848454
49	2 6901961	2 6910815	2 6919651	2 6928469	2 6937269
50	6989700	6998377	7007037	7015680	7024305
51	7075702	7084209	7092700	7101174	7109631
52	7160033	7168377	7176705	7185017	7193313
53	7242759	7250945	7259116	7267272	7275412
54	7323937	7331973	7339993	7347998	7355989
55	2 7403627	2 7411516	2 7419391	2 7427251	2 7435098
56	7481880	7489628	7497363	7505084	7512791
57	7558748	7566361	7573960	7581546	7589119
58	7634280	7641761	7649230	7656685	7664128
59	7708520	7715875	7723217	7730547	7737864
60	7781512	7788745	7795965	7803173	7810369
61	2 7853298	2 7860412	2 7867514	2 7874605	2 7881684
62	7923917	7930916	7937904	7944880	7951846
63	7993405	8000293	8007171	8014037	8020892
64	8061800	8068580	8075350	8082110	8088859
65	8129133	8135810	8142776	8149132	8155777
66	8195439	8202014	8208580	8215135	8221681
67	2 8260748	2 8267225	2 8273693	2 8280151	2 8286599
68	8325089	8331471	8337844	8344207	8350561
69	8388491	8394780	8401061	8407332	8413595
70	8450080	8457180	8463371	8469553	8475726
71	8512583	8518696	8524800	8530895	8536982
72	8573325	8579353	8585372	8591383	8597387
73	8633229	8639174	8645111	8651040	8656960

N.	5	6	7	8	9
37	2 5740313	2 5751878	2 5763413	2 5774918	2 5786392
38	5854602	5865873	5877110	5888317	5899496
39	5965971	5976952	5987905	5998831	6009729
40	6074550	6085260	6095944	6106602	6117233
41	6180481	6190933	6201360	6211763	6222140
42	6283889	6294096	6304279	6314438	6324573
43	2 6384892	2 6394865	2 6404814	2 6414741	2 6424645
44	6483600	6493348	6503075	6512780	6522463
45	6580114	6589648	6599162	6608655	6618127
46	6674529	6683859	6693169	6702458	6711728
47	6766936	6776069	6785184	6794279	6803355
48	6857417	6866362	6875290	6884198	6893088
49	2 6946052	2 6954817	2 6963564	2 6972293	2 6981005
50	7032914	7041505	7050079	7058637	7067178
51	7118072	7126497	7134905	7143297	7151673
52	7201593	7209857	7218106	7226339	7234557
53	7283538	7291648	7299743	7307822	7315888
54	7363965	7371926	7379873	7387805	7395723
55	2 7442930	2 7450748	2 7458552	2 7466342	2 7474118
56	7520484	7528164	7535830	7543483	7551123
57	7596678	7604225	7611758	7619278	7626786
58	7671558	7678976	7686381	7693773	7701153
59	7745170	7752462	7759743	7767012	7774268
60	7817554	7824726	7831887	7839036	7846173
61	2 7888751	2 7895807	2 7902852	2 7909885	2 7916906
62	7958800	7965743	7972675	7979596	7986506
63	8027737	8034571	8041394	8048206	8055008
64	8095597	8102325	8109043	8115750	8122447
65	8162413	8169038	8175654	8182259	8188854
66	8228216	8234742	8241258	8247765	8254261
67	2 8293038	2 8299457	2 8305887	2 8312297	2 8318698
68	8356906	8363241	8369567	8375884	8382192
69	8419843	8426092	8432328	8438554	8444772
70	8481891	8488047	8494194	8500332	8506462
71	8543060	8549134	8555191	8561244	8567289
72	8603380	8609366	8615344	8621314	8627275
73	8662873	8668778	8674675	8680564	8686444

N.	0	1	2	3	4
74	2 8692317	2 8698182	2 8704039	2 8709888	2 8715729
75	8750612	8756399	8762178	8767950	8773713
76	8808136	8813845	8819550	8825245	8830933
77	8864907	8870544	8876170	8881795	8887410
78	8920946	8926510	8932067	8937618	8943161
79	8976271	8981765	8987252	8992732	8998205
80	2 9030900	2 9036325	2 9041744	2 9047155	2 9052560
81	9084850	9090208	9095560	9100905	9106244
82	9138138	9143431	9148718	9153998	9159272
83	9190781	9196110	9201233	9206450	9211660
84	9242793	9247960	9253121	9258276	9263424
85	9294189	9299296	9304396	9309490	9314579
86	2 9344984	2 9350031	2 9355073	2 9360108	2 9365137
87	9395192	9400181	9405165	9410142	9415114
88	9444827	9449759	9454686	9459607	9464523
89	9493900	9498777	9503648	9508514	9513375
90	9542425	9547248	9552005	9556877	9561684
91	9590414	9595184	9599948	9604708	9609462
92	2 9637878	2 9642596	2 9647309	2 9652017	2 9656720
93	9684829	9689497	9694159	9698816	9703469
94	9731278	9735896	9740509	9745117	9749720
95	9777236	9781805	9786369	9790929	9795484
96	9822712	9827234	9831750	9836263	9840770
97	9867717	9872192	9876663	9881128	9885589
98	2 9912261	2 9916690	2 9921115	2 9925535	2 9929951
99	9956352	9960736	9965117	9969492	9973864
100	3 0000000	3 0004341	3 0008677	3 0013009	3 0017337
101	0043214	0047511	0051805	0056094	0060379
102	0086002	0090257	0094509	0098756	0102999
103	0128372	0132587	0136794	0141003	0145205
104	3 0170333	3 0174507	3 0178677	3 0182843	3 0187005
105	0211893	0216027	0220157	0224284	0228406
106	0253059	0257154	0261245	0265333	0269416
107	0293838	0297895	0301948	0305997	0310043
108	0334227	0338257	0342273	0346284	0350293
109	0374265	0378247	0382226	0386202	0390173
110	0413927	0417873	0421816	0425755	0429691

N.	5	6	7	8	9
74	2 8721563	2 8727388	2 8733206	2 8739016	2 8744818
75	8779469	8785218	8790959	8796692	8802418
76	8836614	8842288	8847953	8853612	8859263
77	8893017	8898617	8904210	8909796	8915374
78	8948696	8954225	8959747	8965262	8970770
79	8003671	9009131	9014583	9020029	9025408
80	2 9057959	2 9063350	2 9068735	2 9074114	2 9079485
81	9111576	9116901	9122220	9127533	9132839
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903	9559282	9559762	9560243	9560723	9561204
904	9564686	9564566	9565046	9565526	9566006
905	9568885	9569364	9569844	9570323	9570803
906	3 9573678	3 9574157	3 9574636	3 9575115	3 9575594
907	9578466	9578945	9579423	9579902	9580380
908	9583249	9583727	9584305	9584683	9585161
909	9588027	9588505	9588982	9589459	9589937
910	9592799	9593276	9593753	9594230	9594707
911	9597567	9598043	9598 20	9598996	9599472
912	3 9602329	3 9602805	3 9603280	3 9603756	3 9604232
913	9607086	9607561	9608036	9608512	9608987
914	9611837	9612312	9612787	9613262	9613736
915	9616583	9617058	9617532	9618006	9618481
916	9621325	9621799	9622232	9622746	9623220
917	9626061	9626534	9627007	9627481	9627954
918	3 9630792	3 9631264	3 9631737	3 9632210	3 9632683
919	9635517	9635990	9626462	9636934	9637406
920	9640238	9640710	9641181	96416 3	9642125
921	9644953	9645425	9645896	9646367	9646838
922	9649664	9650134	9650605	9651076	9651546
923	9654369	9654839	9655309	9655780	9656250
924	9659069	9659539	9660009	9660478	9660948

N.	0	1	2	3	4
925	3 9661417	3 9661886	3 9662356	3 9662828	3 9663295
926	9666110	9666579	9667048	9667517	9667985
927	9670797	9671266	9671734	9672203	9672671
928	9675480	9675498	9676416	9676883	9677351
929	9680157	9680625	9681092	9681559	9682027
930	9684829	9685296	9685763	9686230	9686697
931	3 9689497	3 9689963	3 9690430	3 9690896	3 9691362
932	9694159	9694625	9695091	9695557	9696023
933	9698816	9699282	9699747	9700213	9700678
934	9703469	9703934	9704399	9704863	9705328
935	9708116	9708581	9709045	9709509	9709974
936	9712758	9713222	9713686	9714150	9714614
937	3 9717396	3 9717859	3 9718323	3 9718786	3 9719249
938	9722028	9722491	9722954	9723417	9723880
939	9726656	9727118	9727581	9728043	9728506
940	9731278	9731741	9732202	9732664	9733126
941	9735895	9736358	9736819	9737281	9737742
942	9740509	9740970	9741431	9741892	9742353
943	3 9745117	3 9745577	3 9746038	3 9746498	3 9746959
944	9749720	9750180	9750640	9751100	9751560
945	9754318	9754778	9755237	9755697	9756156
946	9758911	9759370	9759829	9760288	9760747
947	9763500	9763958	9764417	9764875	9765334
948	9768083	9768541	9768999	9769457	9769915
949	3 9772662	3 9773120	3 9773577	3 9774035	3 9774492
950	9777236	9777693	9778150	9778607	9779064
951	9781805	9782262	9782718	9783175	9783631
952	9786369	9786826	9787282	9787738	9788194
953	9790929	9791385	9791840	9792296	9792751
954	9795484	9795939	9796394	9796849	9797304
955	3 9800034	3 9800488	3 9800943	3 9801398	3 9801852
956	9804579	9805033	9805487	9805942	9806396
957	9809119	9809573	9810027	9810481	9810934
958	9813655	9814108	9814562	9815015	9815468
959	9818182	9818639	9819092	9819544	9819997
960	9822712	9823165	9823617	9824069	9824522
961	9827234	9827686	9828138	9828589	9829041

N.	5	6	7	8	9
925	3 9663764	3 9664233	3 9664703	3 9665172	3 9665641
926	9668454	9668923	9669392	9669860	9670329
927	9673139	9673607	9674076	9674544	9675012
928	9677819	9678287	9678754	9679222	9679690
929	9682494	9682961	9683428	9683895	9684362
930	9687164	9687630	9688097	9688564	9689030
931	3 9691829	3 9692295	3 9692761	3 9693227	3 9693693
932	9696488	9696954	9697420	9697885	9698351
933	9701143	9701608	9702074	9702539	9703004
934	9705793	9706258	9706722	9707187	9707652
935	9710438	9710902	9711366	9711830	9712294
936	9715078	9715542	9716 05	9716469	9716932
937	3 9719713	3 9720176	3 9720639	3 9721102	3 9721565
938	9724343	9724805	9725268	9725731	9726193
939	9728968	9729430	9729892	9730354	9730816
940	9733588	9734050	9734511	9734973	9735435
941	9738203	9738664	9739126	9739587	9740048
942	9742814	9743274	9743735	9744196	9744656
943	3 9747419	3 9747879	3 9748 40	3 9748800	3 9749260
944	9752020	9752479	9752939	9753399	9753858
945	9756615	9757075	9757534	9757993	9758452
946	9761206	9761665	9762124	9762582	9763041
947	9765702	9766251	9766709	9767167	9767625
948	9770373	9770831	9771289	9771747	9772204
949	3 9774950	3 9775407	3 9775864	3 9776322	3 9776779
950	9779521	9779978	9780435	9780892	9781348
951	9784088	9784544	9785001	9785457	9785913
952	9788650	9789106	9789562	9790017	9790473
953	9793207	9793662	9794118	9794573	9795028
954	9797759	9798214	9798669	9799124	9799579
955	3 9802307	3 9802761	3 9803216	3 9803670	3 9804125
956	9806850	9807304	9807758	9808212	9808666
957	9811388	9811841	9812295	9812748	9813202
958	9815921	9816374	9816827	9817280	9817733
959	9820450	9820902	9821355	9821807	9822260
960	9824974	9825426	9825878	9826330	9826782
961	9829493	9829945	9830306	9830848	9831299

N.	0	1	2	3	4
962	3 9831751	3 9832202	3 9832654	3 9833105	3 9833556
963	9836263	9836714	9837165	9837616	9838066
964	9840770	9841221	9841671	9842122	9842572
965	9845273	9845723	9846173	9846623	9847073
966	9849771	9850221	9850670	9851120	9851569
967	9854265	9854714	9855163	9855612	9856061
968	3 9858754	3 9859202	3 9859651	3 9860099	3 9860548
969	9863238	9863686	9864134	9864582	9865030
970	9867717	9868165	9868613	9869060	9869508
971	9872192	9872640	9873087	9873534	9873981
972	9876668	9877109	9877556	9878003	9878449
973	9881128	9881575	9882021	9882467	9882913
974	3 9885590	3 9886035	3 9886481	3 9886927	3 9887373
975	9890046	9890492	9890937	9891382	9891828
976	9894498	9894943	9895388	9895833	9896278
977	9898946	9899390	9899835	9900279	9900723
978	9903389	9903833	9904277	9904721	9905164
979	9907827	9908270	9908714	9909158	9909601
980	3 9912261	3 9912704	3 9913147	3 9913590	3 9914033
981	9916690	9917133	9917575	9918018	9918461
982	9921115	9921557	9921999	9922441	9922884
983	9925535	9925977	9926419	9926860	9927302
984	9929951	9930392	9930834	9931275	9931716
985	9934362	9934803	9935244	9935685	9936126
986	3 9938769	3 9939210	3 9939650	3 9940090	3 9940531
987	9943172	9943612	9944051	9944491	9944931
988	9947569	9948009	9948448	9948888	9949327
989	9951963	9952402	9952841	9953280	9953719
990	9956352	9956791	9957229	9957668	9958106
991	9960737	9961175	9961613	9962051	9962489
992	3 9965117	3 9965554	3 9965992	3 9966430	3 9966868
993	9969492	9969930	9970367	9970804	9971242
994	9973864	9974301	9974738	9975174	9975611
995	9978231	9978667	9979104	9979540	9979976
996	9982593	9983029	9983465	9983901	9984337
997	9986952	9987387	9987823	9988268	9988694
998	9991305	9991740	9992176	9994611	9993046
999	9995655	9996090	9996524	9992959	9997393

N.	5	6	7	8	9
962	3 9834007	3 9834459	3 9834910	3 9835361	3 9835812
963	9838517	9838968	9839419	9839869	9840320
964	9843022	9843473	9843923	9844373	9844823
965	9847523	9847973	9848422	9848872	9849322
966	9852019	9852468	9852917	9853366	9853816
967	9856510	9856959	9857407	9857856	9858305
968	3 9860996	3 9861445	3 9861893	3 9862341	3 9862790
969	9865478	9865926	9866374	9866822	9867270
970	9869955	9870403	9870850	9871298	9871745
971	9874428	9824875	9875322	9875769	9876216
972	9878896	9879343	9879789	9880236	9880682
973	9883360	9883806	9884252	9884698	9885144
974	3 9887818	3 9888264	3 9888710	3 9889155	3 9889601
975	9892273	9892718	9893163	9893608	9894053
976	9896722	9897167	9897612	9898056	9898501
977	9901168	9901612	9902056	9902500	9902944
978	9905608	9906052	9906496	9906940	9907383
979	9910044	9910488	9910931	9911374	9911818
980	3 9914476	3 9914919	3 9915362	3 9915805	3 9916247
981	9918903	9919345	9919788	9920230	9920673
982	9923326	9923768	9924210	9924651	9925093
983	9927744	9928185	9928627	9929068	9929510
984	9932157	9932598	9933029	9933480	9933921
985	9936566	9937007	9937448	9937888	9938329
986	3 9940971	3 9941411	3 9941851	3 9942291	3 9942731
987	9945371	9945811	9946251	9946690	9947130
988	9949767	9950206	9950645	9951085	9951524
989	9954158	9954597	9955036	9955474	9955913
990	9958545	9958983	9959422	9959860	9960298
991	9962927	9963365	9963803	9964241	9964679
992	3 9967303	3 9967743	3 9968180	3 9968618	3 9969055
993	9971679	9972116	9972553	9972990	9973427
994	9976048	9976485	9976921	9977358	9977794
995	9980413	9980849	9981285	9981721	9982157
996	9984773	9985209	9985645	9986080	9986516
997	9989129	9989564	9990000	9990435	9990870
998	9993481	9993916	9994350	9994785	9995220
999	9997828	9998262	9998697	9999131	9999567

A

TRIANGULAR CANON Logarithmical:

OR,

A TABLE

OF

Artificial SINES, TANGENTS; And the *Complements* Arithmetical of *Sines*, Supplying the Use of *Sines*, the Radius 10.0000000. And to every Degree and Minute of the *Quadrant*.

LONDON, Printed by *J. Gain* in Upper *Moor-Fields*, next Door but one to the *Flying Horse*, 1685.

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	0	0 0000000	0	*Infinite*	60	10 0000000	.0000000
1	6 4637260	9 9999999	6 4637261	13 5362739	59	3 5362739	.0000000
2	6 7647561	9 9999999	6 7647562	12 2352438	58	3 2352439	.0000001
3	6 9408473	9 9999998	6 9408475	13 0591525	57	3 0591527	.0000002
4	7 0657860	9 9999997	7 0657863	12 9342137	56	2 9342140	.0000003
5	7 1626960	9 9999995	7 1626964	12 8373036	55	2 8373040	.0000005
6	7 2418771	9 9999993	7 2418778	12 7581222	54	2 7581229	.0000007
7	7 3088239	9 9999991	7 3088247	12 6911752	53	2 6911761	.0000009
8	7 3668157	9 9999988	7 3668169	12 6331831	52	2 6331843	.0000012
9	7 4179681	9 9999985	7 4179696	12 5820304	51	2 5820319	.0000015
10	7 4637255	9 9999982	7 4637273	12 5362725	50	2 5362745	.0000018
11	7 5051181	9 9999978	7 5051203	12 4948797	49	2 4948819	.0000022
12	7 5429065	9 9999974	7 5429091	12 4570909	48	2 4570935	.0000026
13	7 5776684	9 9999969	7 5776715	12 4223285	47	2 4223316	.0000031
14	7 6098530	9 9999964	7 6098566	12 3901434	46	2 3901470	.0000036
15	7 6398160	9 9999959	7 6398201	12 3601799	45	2 3601840	.0000041
16	7 6678445	9 9999953	7 6678492	12 3321508	44	2 3321555	.0000047
17	7 6941733	9 9999947	7 6941786	12 3058214	43	2 3058267	.0000053
18	7 7189966	9 9999940	7 7190026	12 2809974	42	2 2810034	.0000060
19	7 7424775	9 9999934	7 7424841	12 2575159	41	2 2575225	.0000066
20	7 7647537	9 9999927	7 7647610	12 2352390	40	2 2352463	.0000073
21	7 7859427	9 9999919	7 7859508	12 2140492	39	2 2140573	.0000081
22	7 8061458	9 9999911	7 8061547	12 1938453	38	2 1938542	.0000089
23	7 8254507	9 9999903	7 8254604	12 1745396	37	2 1745493	.0000097
24	7 8439338	9 9999894	7 8439444	12 1560556	36	2 1560662	.0000106
25	7 8616623	9 9999885	7 8616738	12 1383262	35	2 1383377	.0000115
26	7 8786953	9 9999876	7 8787077	12 1212923	34	2 1213047	.0000124
27	7 8950854	9 9999866	7 8950988	12 1049012	33	2 1049146	.0000134
28	7 9108793	9 9999856	7 9108938	12 0891062	32	2 0891207	.0000144
29	7 9261190	9 9999845	7 9261344	12 0738656	31	2 0738810	.0000155
30	7 9408419	9 9999835	7 9408584	12 0591416	30	2 0591581	.0000165

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	7 9408419	9 9999835	7 9404584	12 0591416	30	2 0591581	.0000185
31	7 9550819	9 9999823	7 9550996	12 0449004	29	2 0449181	.0000177
32	7 9688698	9 9999812	7 9688886	12 0311114	28	2 0311302	.0000188
33	7 9822334	9 9999800	7 9822534	12 0177466	27	2 0177666	.0000200
34	7 9951980	9 9999788	7 9952192	12 0047808	26	2 0048020	.0000212
35	8 0077867	9 9999775	8 0078092	11 9921908	25	1 9922133	.0000225
36	8 0200207	9 9999762	8 0200445	11 9799555	24	1 9799793	.0000238
37	8 0319195	9 9999748	8 0319446	11 9680554	23	1 9680805	.0000252
38	8 0435009	9 9999735	8 0435274	11 9564726	22	1 9564991	.0000265
39	8 0547814	9 9999721	8 0548094	11 9451806	21	1 9452186	.0000279
40	8 0657763	9 9999706	8 0658057	11 9341943	20	1 9342237	.0000294
41	8 0764997	9 9999691	8 0765306	11 9234694	19	1 9235003	.0000309
42	8 0869646	9 9999676	8 0869970	11 9130030	18	1 9130354	.0000324
43	8 0971832	9 9999660	8 0972172	11 9027828	17	1 9028168	.0000340
44	8 1071669	9 9999644	8 1072025	11 8927975	16	1 8928331	.0000356
45	8 1169262	9 9999628	8 1169634	11 8830366	15	1 8830738	.0000372
46	8 1264710	9 9999611	8 1265099	11 8734901	14	1 8735290	.0000389
47	8 1358104	9 9999594	8 1358510	11 8641490	13	1 8641896	.0000406
48	8 1449532	0 9999577	8 1449956	11 8550044	12	1 8550468	.0000423
49	8 1539075	9 9999559	8 1539516	11 8460484	11	1 8460925	.0000441
50	8 1626808	9 9999541	8 1627267	11 8372733	10	1 8373192	.0000459
51	8 1712803	9 9999522	8 1713282	11 8286718	9	1 8287196	.0000478
52	8 1797129	9 9999503	8 1797626	11 8202374	8	1 8202871	.0000497
53	8 1879848	9 9999484	8 1880364	11 8119636	7	1 8120152	.0000516
54	8 1961020	9 9999464	8 1961556	11 8038444	6	1 8038980	.0000536
55	8 2040703	9 9999444	8 2041259	11 7958741	5	1 7959297	.0000556
56	8 2118949	9 9999424	8 2119526	11 7880474	4	1 7881051	.0000576
57	8 2195811	9 9999403	8 2196408	11 7803592	3	1 7804189	.0000597
58	8 2271335	9 9999382	8 2271953	11 7728047	2	1 7728665	.0000618
59	8 2345568	9 9999360	8 2346208	11 7653792	1	1 7654432	.0000640
60	8 2418553	9 9999338	8 2419215	11 7580785	0	1 7581447	.0000662

SINE Comlp ment.	Sine.	Tangent. Comple-ment.	Tang.	M.

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	8 2418553	9 9999338	8 2419215	11 7580785	60	1 7581447	.0000651
1	8 2490332	9 9999316	8 2491015	11 7508685	59	1 7509668	.0000684
2	8 2560943	9 9999294	8 2561649	11 7438351	58	1 7439057	.0000706
3	8 2630424	9 9999271	8 2631153	11 7368847	57	1 7369576	.0000729
4	8 2698810	9 9999247	8 2699563	11 7300437	56	1 7301190	.0000753
5	8 2766136	9 9999224	8 2766912	11 7233088	55	1 7233864	.0000776
6	8 2832434	9 9999200	8 2833234	11 7166766	54	1 7167566	.0000800
7	8 2897734	9 9999175	8 2898559	11 7101441	53	1 7102266	.0000825
8	8 2962067	9 9999150	8 2962917	11 7037083	52	1 7037933	.0000850
9	8 3025460	9 9999125	8 3026335	11 6973665	51	1 6974450	.0000875
10	8 3087941	9 9999100	8 3088842	11 6912059	50	1 6911158	.0000900
11	8 3149536	9 9999074	8 3150462	11 6849538	49	1 6850464	.0000926
12	8 3210269	9 9999047	8 3211221	11 6788779	48	1 6789731	.0000953
13	8 3270163	9 9999021	8 3271143	11 6728857	47	1 6729837	.0000979
14	8 3329243	9 9998994	8 3330246	11 6669751	46	1 6670757	.0001006
15	8 3387529	9 9998966	8 3388563	11 6611437	45	1 6612471	.0001034
16	8 3445043	9 9998939	8 3446105	11 6553895	44	1 6554957	.0001061
17	8 3501805	9 9998911	8 3502895	11 6497105	43	1 6498195	.0001089
18	8 3557835	9 9998882	8 3558953	11 6441047	42	1 6442165	.0001118
19	8 3613150	9 9998853	8 3614297	11 6385703	41	1 6386850	.0001147
20	8 3667769	9 9998824	8 3668945	11 6331055	40	1 6332231	.0001176
21	8 3721710	9 9998794	8 3722915	11 6277085	39	1 6278290	.0001206
22	8 3774988	9 9998764	8 3776223	11 6223777	38	1 6225012	.0001236
23	8 3827620	9 9998734	8 3828886	11 6171114	37	1 6172380	.0001266
24	8 3879622	9 9998703	8 3880918	11 6119082	36	1 6120378	.0001297
25	8 3931008	9 9998672	8 3932336	11 6067664	35	1 6068992	.0001328
26	8 3981793	9 9998641	8 3983152	11 6016848	34	1 6018207	.0001359
27	8 4031990	9 9998609	8 4033381	11 5966619	33	1 5968010	.0001391
28	8 4081614	9 9998577	8 4083037	11 5916963	32	1 5918386	.0001423
29	8 4130676	9 9998544	8 4132132	11 5867868	31	1 5869324	.0001456
30	8 4179190	9 9998512	8 4180679	11 5819321	30	1 5820810	.0001488

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith of Sine Com
30	8 4179190	9 9998512	8 4180679	11 5819321	30	1 5820810	.0001488
31	8 4227168	9 9998478	8 4228690	11 5771310	29	1 5772832	.0001522
32	8 4274621	9 9998445	8 4276176	11 5723824	28	1 5725379	.0001555
33	8 4321561	9 9998411	8 4323150	11 5676850	27	1 5678439	.0001589
34	8 4367999	9 9998376	8 4369622	11 5630378	26	1 5632001	.0001624
35	8 4413944	9 9998342	8 4415603	11 5584397	25	1 5586056	.0001658
36	8 4459409	9 9998306	8 4461103	11 5538897	24	1 5540591	.0001694
37	8 4504402	9 9998271	8 4506131	11 5493869	23	1 5495598	.0001729
38	8 4548934	9 9998235	8 4550699	11 5449301	22	1 5451066	.0001765
39	8 4593013	9 9998199	8 4594814	11 5405186	21	1 5406987	.0001801
40	8 4636649	9 9998162	8 4638486	11 5361514	20	1 5363351	.0001838
41	8 4679850	9 9998125	8 4681725	11 5318275	19	1 5320150	.0001875
42	8 4722626	9 9998088	8 4724538	11 5275462	18	1 5277374	.0001912
43	8 4764984	9 9998059	8 4766933	11 5233067	17	1 5235016	.0001950
44	8 4806932	9 9998012	8 4808920	11 5191080	16	1 5193068	.0001988
45	8 4848479	9 9997974	8 4850505	11 5149495	15	1 5151521	.0002026
46	8 4889632	9 9997935	8 4891696	11 5108304	14	1 5110368	.0002065
47	8 4930398	9 9997896	8 4932502	11 5067498	13	1 5069602	.0002104
48	8 4970784	0 9997856	8 4972728	11 5027072	12	1 5029216	.0002144
49	8 5010798	9 9997817	8 5012982	11 4987018	11	1 4989202	.0002183
50	8 5050447	9 9997776	8 5052671	11 4947329	10	1 4949553	.0002224
51	8 5089736	9 9997736	8 5092001	11 4907999	9	1 4910264	.0002264
52	8 5128674	9 9997695	8 5130978	11 4869022	8	1 4871327	.0002305
53	8 5167264	9 9997653	8 5169610	11 4830387	7	1 4832736	.0002347
54	8 5205514	9 9997612	8 5207902	11 4792098	6	1 4794486	.0002388
55	8 5243430	9 9997570	8 5245860	11 4754140	5	1 4756570	.0002430
56	8 5281017	9 9997527	8 5283490	11 4716510	4	1 4718983	.0002473
57	8 5318281	9 9997484	8 5320797	11 4679203	3	1 4681719	.0002516
58	8 5355228	9 9997441	8 5357787	11 4642214	2	1 4644772	.0002559
59	8 5391864	9 9997398	8 5394466	11 4605534	1	1 4608137	.0002602
60	8 5428192	9 9997354	8 5430838	11 4569162	0	1 4571808	.0002646

SINE Complement.	Sine.	Tangent. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	8 5428192	9 9997354	8 5430838	11 4569162	60	1 4571808	.0002646
1	8 5464218	9 9997309	8 5466909	11 4533091	59	1 4535782	.0002691
2	8 5499948	9 9997265	8 5502683	11 4497317	58	1 4500052	.0002735
3	8 5535386	9 9997220	8 5538166	11 4461834	57	1 4464614	.0002780
4	8 5570536	9 9997174	8 5573362	11 4426638	56	1 4429464	.0002826
5	8 5605404	9 9997128	8 5608276	11 4391724	55	1 4394596	.0002872
6	8 5639994	9 9997082	8 5642912	11 4357088	54	1 4360006	.0002918
7	8 5674310	9 9997036	8 5677275	11 4322725	53	1 4325690	.0002264
8	8 5708357	9 9996989	8 5711368	11 4288632	52	1 4291643	.0003011
9	8 5742139	9 9996942	8 5745197	11 4254803	51	1 4257861	.0003058
10	8 5775660	9 9996894	8 5778766	11 4221234	50	1 4224340	.0003106
11	8 5808923	9 9996846	8 5812077	11 4187923	49	1 4191077	.0003154
12	8 5841933	9 9996798	8 5845136	11 4154864	48	1 4158067	.0003202
13	8 5874694	9 9996749	8 5877945	11 4122055	47	1 4125306	.0003251
14	8 5907209	9 9996700	8 5910509	11 4089491	46	1 4092791	.0003300
15	8 5939483	9 9996650	8 5942832	11 4057168	45	1 4060517	.0003350
16	8 5971517	9 9996601	8 5974917	11 4025083	44	1 4028443	.0003399
17	8 6003317	9 9996550	8 6006767	11 3993233	43	1 3996683	.0003450
18	8 6034886	9 9996500	8 6038386	11 3961614	42	1 3965114	.0003500
19	8 6066226	9 9996449	8 6069777	11 3930223	41	1 3933774	.0003551
20	8 6097341	9 9996398	8 6100943	11 3899057	40	1 3902659	.0003602
21	8 6128235	9 9996346	8 6131889	11 3868111	39	1 3871765	.0003654
22	8 6158910	9 9996294	8 6162616	11 3837384	38	1 3841090	.0003706
23	8 6189369	9 9996242	8 6193127	11 3806873	37	1 3810631	.0003758
24	8 6219616	9 9996189	8 6223427	11 3776573	36	1 3780384	.0003811
25	8 6249654	9 9996136	8 6253518	11 3746482	35	1 3750347	.0003864
26	8 6279484	9 9996082	8 6283402	11 3716598	34	1 3720516	.0003918
27	8 6309111	9 9996028	8 6313083	11 3686917	33	1 3690889	.0003972
28	8 6338537	9 9995974	8 6342563	11 3657437	32	1 3661463	.0004026
29	8 6367764	9 9995919	8 6371845	11 3628155	31	1 3632236	.0004081
30	8 6396796	9 9995865	8 6400931	11 3599069	30	1 3603204	.0004135

SINE Comple-ment.	Sine	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
30	6 3967968	9 9995865	8 6400931	11 3599069	30	1 3603204	.0004135
31	8 6425634	9 9995809	8 6429825	11 3570175	29	1 3574366	.0004191
32	8 6454282	9 9995753	8 6458528	11 3541472	28	1 3545718	.0004247
33	8 6482742	9 9995697	8 6487044	11 3512956	27	1 3517258	.0004303
34	8 6511016	9 9995641	8 6515375	11 3484625	26	1 3488984	.0004359
35	8 6539107	9 9995584	8 6543525	11 3456478	25	1 3460893	.0004416
36	8 6567017	9 9995527	8 6571490	11 3428510	24	1 3432983	.0004473
37	8 6594748	9 9995469	8 6599279	11 3400721	23	1 3405252	.0004530
38	8 6622303	9 9995411	8 6626891	11 3373109	22	1 3377697	.0004589
39	8 6649684	9 9995353	8 6654331	11 3345669	21	1 3350316	.0004647
40	8 6676893	9 9995294	8 6681598	11 3318402	20	1 3323107	.0004705
41	8 6703933	9 9995236	8 6708697	11 3291303	19	1 3296068	.0004764
42	8 6730804	9 9995176	8 6735628	11 3264372	18	1 3269196	.0004824
43	8 6757510	9 9995116	8 6762393	11 3237607	17	1 3242490	.0004884
44	8 6784052	9 9995056	8 6788996	11 3211004	16	1 3215948	.0004944
45	8 6810432	9 9994996	8 6815437	11 3184563	15	1 3189567	.0005004
46	8 6836654	9 9994935	8 6841719	11 3158281	14	1 3163346	.0005065
47	8 6862718	9 9994874	8 6867844	11 3132156	13	1 3137282	.0005126
48	8 6888625	9 9994812	8 6893813	11 3106187	12	1 3111375	.0005188
49	8 6914379	9 9994750	8 6919629	11 3080371	11	1 3085621	.0005250
50	8 6939980	9 9994688	8 6945292	11 3054708	10	1 3060019	.0005312
51	8 6965431	9 9994625	8 6970806	11 3029194	9	1 3034569	.0005372
52	8 6990734	9 9994562	8 6996172	11 3003828	8	1 3009266	.0005438
53	8 7015899	9 9994498	8 7021390	11 2978610	7	1 2984111	.0005502
54	8 7040899	9 9994435	8 7046465	11 2953535	6	1 2959101	.0005565
55	8 7065766	9 9994370	8 7071395	11 2928605	5	1 2934234	.0005630
56	8 7090490	9 9994306	8 7096185	11 2903815	4	1 2909510	.0005694
57	8 7115075	9 9994241	8 7120834	11 2879166	3	1 2884925	.0005759
58	8 7139520	9 9994176	8 7145345	11 2854655	2	1 2860480	.0005824
59	8 7163829	9 9994110	8 7169719	11 2830281	1	1 2836171	.0005890
60	8 7188002	9 9994044	8 7193958	11 2806042	0	1 2811998	.0005956

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com.
0	8 7188002	9 9994044	8 7193958	11 2806042	60	1 2811998	.0005956
1	8 7112040	9 9993978	8 7218065	11 2781937	59	1 2781937	.0006022
2	8 7235945	9 9993911	8 7242035	11 2757965	58	1 2764054	.0006089
3	8 7259721	9 9993844	8 7265877	11 2734123	57	1 2740279	.0006156
4	8 7283366	9 9993776	8 7289589	11 1701411	56	1 2716634	.0006224
5	8 7306882	9 9993708	8 7313174	11 2686826	55	1 2693118	.0006292
6	8 7330272	9 9993640	8 7336631	11 2663369	54	1 2669728	.0006360
7	8 7353535	9 9993572	8 7359964	11 2640036	53	1 2646465	.0006428
8	8 7376675	9 9993503	8 7383172	11 2616828	52	1 2623325	.0006497
9	8 7399691	9 9993433	8 7406258	11 2593742	51	1 2600309	.0006567
10	8 7422586	9 9993364	8 7429222	11 2570778	50	1 2577414	.0006636
11	8 7445360	9 9993293	8 7452067	11 2547933	49	1 2554640	.0006707
12	8 7468015	9 9993223	8 7474792	11 2525208	48	1 2531985	.0006777
13	8 7490553	9 9993152	8 7497400	11 2502600	47	1 2509447	.0006848
14	8 7512973	9 9993081	8 7519892	11 2480108	46	1 2487027	.0006919
15	8 7535278	9 9993009	8 7542269	11 2457731	45	1 2464722	.0006991
16	8 7557469	9 9992938	8 7564531	11 2435469	44	1 2442531	.0007062
17	8 7579546	9 9992865	8 7586681	11 2413319	43	1 2420454	.0007135
18	8 7601512	9 9992793	8 7608719	11 2391281	42	1 2398488	.0007207
19	8 7623366	9 9992720	8 7630647	11 2369353	41	1 2376634	.0007280
20	8 7645111	9 9992646	8 7652465	11 2347535	40	1 2354889	.0007354
21	8 7666747	9 9992572	8 7674175	11 2325825	39	1 2333253	.0007428
22	8 7688275	9 9992498	8 7695777	11 2304223	38	1 2311725	.0007502
23	8 7709697	9 9992424	8 7717274	11 2282726	37	1 2290303	.0007576
24	8 7731014	9 9992349	8 7738665	11 2261335	36	1 2268986	.0007651
25	8 7752226	9 9992274	8 7759952	11 2240048	35	1 2247774	.0007726
26	8 7773334	9 9992198	8 7781136	11 2218864	34	1 2226666	.0007802
27	8 7794340	9 9992122	8 7802218	11 2197782	33	1 2205660	.0007878
28	8 7815244	9 9992046	8 7823199	11 2176801	32	1 2184756	.0007954
29	8 7836048	9 9991969	8 7844079	11 2155921	31	1 2163952	.0008031
30	8 7856753	9 9991892	8 7864861	11 2135139	30	1 2143247	.0008108

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	8 7856753	9 9991892	8 7864861	11 2135139	30	1 2143247	.0008108
31	8 7877359	9 9991815	8 7885544	11 2114456	29	1 2122641	.0008185
32	8 7897857	9 9991737	8 2906130	11 2093870	28	1 2102133	.0008263
33	8 7918278	9 9991659	8 7926620	11 2073380	27	1 2081722	.0008341
34	8 7938594	9 9991580	8 7947014	11 2052986	26	1 2061406	.0008420
35	8 7958814	9 9991501	8 7967313	11 2032687	25	1 2041186	.0008499
36	8 7978941	9 9991422	8 7987519	11 2012481	24	1 2021059	.0008578
37	8 7998974	9 9991342	8 8007632	11 1992368	23	1 2001026	.0008658
38	8 8018915	9 9991262	8 8027653	11 1972347	22	1 1981085	.0008738
39	8 8038764	9 9991182	8 8047583	11 1952417	21	1 1961236	.0008818
40	8 8058523	9 9991101	8 8067422	11 1932578	20	1 1941477	.0008899
41	8 8078192	9 9991020	8 8087172	11 1912827	19	1 1921808	.0008980
42	8 8097772	9 9990938	8 8106834	11 1893166	18	1 1902228	.0009062
43	8 8117264	9 9990856	8 8126407	11 1873593	17	1 1882736	.0009144
44	8 8136668	9 9990774	8 8145894	11 1854106	16	1 1863332	.0009226
45	8 8155985	9 9990691	8 8165294	11 1834706	15	1 1844015	.0009309
46	8 8175217	9 9990608	8 8184608	11 1815392	14	1 1824783	.0009392
47	8 8194363	9 9990525	8 8203838	11 1796162	13	1 6865637	.0009475
48	8 8213425	0 9990441	8 8222984	11 1777016	12	1 1786575	.0009559
49	8 8232404	9 9990357	8 8242046	11 1757954	11	1 1767596	.0009643
50	8 8251299	9 9990273	8 8261026	11 1738974	10	1 1748701	.0009727
51	8 8270112	9 9990188	8 8279924	11 1720076	9	1 1729888	.0009812
52	8 8288844	9 9990103	8 8298741	11 1701259	8	1 1711156	.0009897
53	8 8307495	9 9990017	8 8317478	11 1682522	7	1 1692505	.0009983
54	8 8326066	9 9989931	8 8336134	11 1663866	6	1 1673934	.0010069
55	8 8344557	9 9989845	8 8354712	11 1645288	5	1 1655443	.0010155
56	8 8362969	9 9989758	8 8373211	11 1626789	4	1 1637031	.0010242
57	8 8381304	9 9989671	8 8391633	11 1608367	3	1 1618696	.0010329
58	8 8399561	9 9989584	8 8409977	11 1590023	2	1 1600439	.0010416
59	8 8417741	9 9989496	8 8428245	11 1571755	1	1 1682259	.0010504
60	8 8435845	9 9989408	8 8446437	11 1553563	0	1 1564155	.0010592

SINE Complement.	Sine.	Tangent. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	8 8435845	9 9989408	8 8446437	11 1553563	60	1 1564155	.0010592
1	8 8453874	9 9989319	8 8464554	11 1535446	59	1 1546126	.0010681
2	8 8471827	9 9989230	8 8482597	11 1517403	58	1 1528173	.0010770
3	8 8489707	9 9989141	8 8500566	11 1499434	57	1 1510293	.0010859
4	8 8507512	9 9989052	8 8518461	11 1481539	56	1 1492488	.0010948
5	8 8525245	9 9988962	8 8536283	11 1463717	55	1 1474755	.0011038
6	8 8542905	9 9988871	8 8554034	11 1445966	54	1 1457095	.0011129
7	8 8560493	9 9988780	8 8571713	11 1428287	53	1 1439507	.0011220
8	8 8578010	9 9988689	8 8589321	11 1410679	52	1 1421990	.0011311
9	8 8595457	9 9988598	8 8606859	11 1393141	51	1 1404543	.0011402
10	8 8612833	9 9988506	8 8624327	11 1375673	50	1 1387167	.0011494
11	8 8630139	9 9988414	8 8641725	11 1358275	49	1 1369861	.0011586
12	8 8647376	9 9988321	8 8659055	11 1340945	48	1 1352624	.0011679
13	8 8664545	9 9988228	8 8676317	11 1323683	47	1 1335455	.0011772
14	8 8681646	9 9988135	8 8693511	11 1306489	46	1 1318354	.0011865
15	8 8698680	9 9988041	8 8710638	11 1289362	45	1 1301320	.0011959
16	8 8715646	9 9987947	8 8727699	11 1272301	44	1 1284354	.0012053
17	8 8732546	9 9987853	8 8744694	11 1255306	43	1 1267454	.0012147
18	8 8749381	9 9987758	8 8761623	11 1238377	42	1 1250619	.0012242
19	8 8766150	9 9987663	8 8778487	11 1221513	41	1 1233850	.0012337
20	8 8782854	9 9987567	8 8795286	11 1204714	40	1 1217146	.0012433
21	8 8799493	9 9987471	8 8812022	11 1187978	39	1 1200507	.0012529
22	8 8816069	9 9987375	8 8828694	11 1171306	38	1 1183931	.0012625
23	8 8832581	9 9987278	8 8845303	11 1154697	37	1 1167419	.0012722
24	8 8849031	9 9987181	8 8861850	11 1138150	36	1 1150969	.0012819
25	8 8865418	9 9987084	8 8878334	11 1121666	35	1 1134582	.0012916
26	8 8881743	9 9986986	8 8894757	11 1105243	34	1 1118257	.0013014
27	8 8898007	9 9986888	8 8911119	11 1088881	33	1 1101993	.0013112
28	8 8914209	9 9986790	8 8927420	11 1072580	32	1 1085791	.0013210
29	8 8930351	9 9986691	8 8943660	11 1056340	31	1 1069649	.0013309
30	8 8946433	9 9986591	8 8959842	11 1040158	30	1 1053567	.0013409

	SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith of Sine Com
30	8 8946433	9 9985591	8 8959842	11 1040158	30	1 1053567	.0013409
31	8 8962455	9 9986492	8 8975963	11 1024037	29	1 1037545	.0013508
32	8 8978418	9 9986392	8 8992026	11 1007974	28	1 1021582	.0013608
33	8 8994322	9 9986292	8 9008030	11 0991970	27	1 1005678	.0013708
34	8 9010168	9 9986191	8 9023977	11 0976023	26	1 0989832	.0013809
35	8 9025955	9 9986090	8 9039866	11 0960134	25	1 0974045	.0013910
36	8 9041685	9 9985988	8 9055697	11 0944303	24	1 0958315	.0014012
37	8 9057358	9 9985886	8 9071472	11 0928528	23	1 0942642	.0014114
38	8 9072975	9 9985784	8 9087190	11 0812810	22	1 0927025	.0014216
39	8 9088535	9 9985682	8 9102853	11 0897147	21	1 0911465	.0014318
40	8 9104039	9 9985579	8 9118469	11 0881540	20	1 0895961	.0014421
41	8 9119478	9 9985475	8 9134012	11 0865988	19	1 0880513	.0014525
42	8 9134880	9 9985372	8 9149509	11 0850491	18	1 0865119	.0014628
43	8 9150219	9 9985268	8 9164952	11 0835048	17	1 0849781	.0014732
44	8 9165504	9 9985163	8 9180340	11 0819660	16	1 0834496	.0014837
45	8 9180734	9 9985058	8 9195675	11 0804325	15	1 0819266	.0014942
46	8 9195911	9 9984953	8 9210957	11 0789043	14	1 0804089	.0015047
47	8 9211034	9 9984848	8 9226186	11 0773814	13	1 0788966	.0015152
48	8 9226105	0 9984742	8 9241393	11 0758637	12	1 0773895	.0015258
49	8 9241123	9 9984636	8 9256487	11 0743513	11	1 0758877	.0015364
50	8 9256089	9 9984529	8 9271560	11 0728440	10	1 0743911	.0015471
51	8 9271003	9 9984422	8 9286581	11 0713419	9	1 0728997	.0015578
52	8 9285866	9 9984315	8 9301552	11 0698448	8	1 0714134	.0015685
53	8 9300678	9 9984207	8 9316471	11 0683529	7	1 0699322	.0015793
54	8 9315439	9 9984099	8 9331340	11 0668660	6	1 0684561	.0015901
55	8 9330150	9 9983990	8 9346160	11 0653840	5	1 0669850	.0016010
56	8 9344811	9 9983881	8 9360929	11 0639071	4	1 0655189	.0016119
57	8 9359422	9 9983772	8 9375650	11 0624351	3	1 0640578	.0016228
58	8 9373983	9 9983663	8 9390321	11 0609679	2	1 0626017	.0016337
59	8 9388496	9 9983553	8 9404944	11 0595056	1	1 0611504	.0016447
60	8 9402960	9 9983442	8 9419518	11 0584082	0	1 0597040	.0016558

SINE Complement.	Sine.	Tangent. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	8 9402960	9 9983442	8 9419518	11 0580482	60	1 0597040	.0016558
1	8 9417376	9 9983331	8 9434044	11 0565956	59	1 0582624	.0016668
2	8 9431743	9 9983220	8 9448523	11 0551477	58	1 0568257	.0016780
3	8 9446063	9 9983109	8 9462954	11 0537046	57	1 0553937	.0016891
4	8 9460335	9 9982997	8 9477338	11 0522662	56	1 0536965	.0017003
5	8 9474561	9 9982885	8 9491675	11 0508324	55	1 0525439	.0017115
6	8 9488739	9 9982772	8 0505967	11 0494033	54	1 0511261	.0017228
7	8 9502871	9 9982660	8 9520211	11 0479789	53	1 0497129	.0017340
8	8 9516957	9 9982546	8 9534410	11 0465590	52	1 0483043	.0017454
9	8 9530996	9 9982433	8 9548564	11 0451436	51	1 0469004	.0017567
10	8 9544991	9 9982318	8 9562672	11 0437328	50	1 0455009	.0017682
11	8 9558940	9 9982204	8 9576735	11 0423265	49	1 0441060	.0017796
12	8 9572843	9 9982089	8 9590754	11 0409246	48	1 0427157	.0017911
13	8 9586703	9 9981974	8 9604728	11 0395272	47	1 0413297	.0018026
14	8 9600517	9 9981859	8 9618659	11 0381341	46	1 0399483	.0018141
15	8 9614288	9 9981743	8 9632545	11 0367455	45	1 0385712	.0018257
16	8 9628014	9 9981626	8 9646388	11 0353612	44	1 0371986	.0018374
17	8 9641697	9 9981510	8 9660188	11 0339812	43	1 0358303	.0018490
18	8 9655337	9 9981393	8 9673944	11 0326056	42	1 0344663	.0018607
19	8 9668934	9 9981275	8 9687658	11 0312342	41	1 0331066	.0018725
20	8 9682487	9 9981158	8 9701330	11 0298670	40	1 0317513	.0018842
21	8 9695999	9 9981040	8 9714959	11 0285041	39	1 0304001	.0018960
22	8 9709468	9 9980921	8 9728547	11 0271453	38	1 0290532	.0019079
23	8 9722895	9 9980802	8 9742092	11 0257908	37	1 0277105	.0019198
24	8 9736280	9 9980683	8 9755597	11 0244403	36	1 0263720	.0019317
25	8 9749624	9 9980563	8 9769060	11 0230940	35	1 0250376	.0019437
26	8 9762926	9 9980443	8 9782483	11 0217517	34	1 0237074	.0019557
27	8 9776188	9 9980323	8 9795865	11 0204135	33	1 0223812	.0019677
28	8 9789408	9 9980202	8 9809206	11 0190794	32	1 0210592	.0019797
29	8 9802589	9 9980081	8 9822507	11 0177493	31	1 0197411	.0019919
30	8 9815729	9 9979960	8 9835769	11 0164231	30	1 0184271	.0020040

	SINE Comple-ment.	Sine	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
30	8 9815729	9 9979960	8 9835769	11 0164231	30	1 0184271	.0020040
31	8 9828829	9 9979838	8 9848991	11 0151009	29	1 0171171	.0020162
32	8 9841889	9 9979716	8 9862173	11 0137827	28	1 0158111	.0020284
33	8 9854910	9 9979593	8 9875317	11 0124683	27	1 0145090	.0020407
34	8 9867891	9 9979470	8 9888421	11 0111579	26	1 0132109	.0020530
35	8 9880834	9 9979347	8 9901487	11 0098513	25	1 0119166	.0020653
36	8 9893737	9 9979223	8 9914514	11 0085486	24	1 0106263	.0020777
37	8 9906602	9 9979099	8 9927503	11 0072497	23	1 0093398	.0020901
38	8 9919429	9 9978975	8 9940454	11 0059546	22	1 0080571	.0021025
39	8 9932217	9 9978850	8 9953367	11 0046633	21	1 0067783	.0021150
40	8 9944968	9 9978725	8 9966243	11 0033757	20	1 0055032	.0021275
41	8 9957681	9 9978599	8 9979081	11 0020919	19	1 0042319	.0021401
42	8 9970356	9 9978473	8 9991883	11 0008117	18	1 0029644	.0021527
43	8 9982994	9 9978347	8 0004647	10 9995353	17	1 0017006	.0021653
44	8 9995595	9 9978220	8 0017375	10 9982625	16	1 0004405	.0021780
45	8 0008160	9 9978093	8 0030066	10 9969934	15	0 9991840	.0021907
46	8 0020687	9 9977966	9 0042721	10 9957279	14	0 9979313	.0022034
47	8 0033179	9 9977838	9 0055340	10 9944660	13	0 9966821	.0022162
48	8 0045634	9 9977710	9 0067925	10 9932076	12	0 9954366	.0022290
49	8 0058053	9 9977582	9 0080471	10 9919529	11	0 9941947	.0022418
50	8 0070436	9 9977453	9 0092984	10 9907016	10	0 9929564	.0022547
51	8 0082784	9 9977323	9 0105461	10 9894539	9	0 9917216	.0022677
52	8 0095096	9 9977194	9 0117993	10 9882097	8	0 9904904	.0022806
53	8 0107374	9 9977064	9 0130310	10 9869680	7	0 9892626	.0022936
54	8 0119616	9 9976933	9 0142682	10 9857318	6	0 9880384	.0023067
55	8 0131823	9 9976803	9 0155021	10 9844979	5	0 9868177	.0023197
56	8 0143996	9 9976672	9 0167325	10 9832675	4	0 9856004	.0023328
57	8 0156135	9 9976540	9 0179594	10 9820406	3	0 9843865	.0023460
58	8 0168239	9 9976408	9 0191831	10 9808169	2	0 9831761	.0023592
59	8 0180309	9 9976276	9 0204033	10 9795967	1	0 9819691	.0023724
60	8 0192346	9 9976143	9 0216202	10 9783798	0	0 9807654	.0023857

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
0	9 0192346	9 9976143	9 0216202	10 9783798	60	0 9807654	.0023857
1	9 0204348	9 9976011	9 0228338	10 9771662	59	0 9795652	.0023989
2	9 0216318	9 9975877	9 0240441	10 9759559	58	0 9783682	.0024123
3	9 0228254	9 9975743	9 0252510	10 9747490	57	0 9771746	.0024257
4	9 0240157	9 9975609	9 0264548	10 9735452	56	0 9759843	.0024391
5	9 0252027	9 9975475	9 0276552	10 9723448	55	0 9747973	.0024525
6	9 0263865	9 9975340	9 0288524	10 9711476	54	0 9736135	.0024660
7	9 0275669	9 9975205	9 0300464	10 9699536	53	0 9724331	.0024795
8	9 0287442	9 9975069	9 0312373	10 9687627	52	0 9712558	.0024931
9	9 0299182	9 9974933	9 0324249	10 9675751	51	0 9700818	.0025067
10	9 0310890	9 9974797	9 0336093	10 9663907	50	0 9689110	.0025203
11	9 0322567	9 9974660	9 0347906	10 9652094	49	0 9677433	.0025340
12	9 0334212	9 9974523	9 0359688	10 9640312	48	0 9665788	.0025477
13	9 0345825	9 9974386	9 0371439	10 9628561	47	0 9654175	.0025614
14	9 0357407	9 9974248	9 0383159	10 9616841	46	0 9642593	.0025752
15	9 0368958	9 9974110	9 0394848	10 9605152	45	0 9631042	.0025890
16	9 0380477	9 9973971	9 0406506	10 9593494	44	0 9619523	.0026029
17	9 0391966	9 9973832	9 0418134	10 9581866	43	0 9608034	.0026167
18	9 0403424	9 9973693	9 0429731	10 9570269	42	0 9596576	.0026307
19	9 0414852	9 9973554	9 0441299	10 9558701	41	0 9585148	.0026446
20	9 0426249	9 9973414	9 0452836	10 9547164	40	0 9573751	.0026586
21	9 0437617	9 9973273	9 0464343	10 9535657	39	0 9562383	.0026727
22	9 0448954	9 9973132	9 0475821	10 9524179	38	0 9551046	.0026868
23	9 0460261	9 9972991	9 0487270	10 9512730	37	0 9539739	.0027009
24	9 0471538	9 9972850	9 0498689	10 9501311	36	0 9528462	.0027150
25	9 0482786	9 9972708	9 0510078	10 9489922	35	0 9517214	.0027292
26	9 0494005	9 9972566	9 0521439	10 9478561	34	0 9505995	.0027434
27	9 0505194	9 9972423	9 0532771	10 9467226	33	0 9494806	.0027577
28	9 0516354	9 9972280	9 0544074	10 9455926	32	0 9483646	.0027720
29	9 0527485	9 9972137	9 0555349	10 9444651	31	0 9472515	.0027863
30	9 0538588	9 9971993	9 0566595	10 9433405	30	0 9461412	.0028007

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
30	9 0538588	9 9971993	9 0566595	10 9433404	30	0 9461412	.0028007
31	9 0549651	9 9971849	9 0577813	10 9422187	29	0 9450339	.0028151
32	9 0560706	9 9971704	9 0589002	10 9410998	28	0 9439294	.0028296
33	9 0571723	9 9971559	9 0600164	10 9399836	27	0 9428277	.0028441
34	9 0582711	9 9971414	9 0611297	10 9388703	26	0 9417289	.0028586
35	9 0593672	9 9971268	9 0622403	10 9377597	25	0 9406328	.0028732
36	9 0604604	9 9971122	9 0633482	10 9366518	24	0 9395396	.0028878
37	9 0615509	9 9970976	9 0644533	10 9355467	23	0 9384491	.0029024
38	9 0626386	9 9970829	9 0655556	10 9344444	22	0 9373614	.0029171
39	9 0632735	9 9979682	9 0666553	10 9333447	21	0 9362765	.0029318
40	9 0648057	9 9970535	9 0677522	10 9322478	20	0 9351943	.0029465
41	9 0658852	9 9970387	9 0688465	10 9311535	19	0 9341148	.0029613
42	9 0669619	9 9970239	9 0699381	10 9300619	18	0 9330381	.0029761
43	9 0680360	9 9970090	9 0710270	10 9289730	17	0 9319640	.0029910
44	9 0691074	9 9969941	9 0721133	10 9278857	16	0 9308926	.0030059
45	9 0701761	9 9969792	9 0731969	10 9268031	15	0 9298239	.0030208
46	9 0712421	9 9969642	9 0742779	10 9257221	14	0 9287579	.0030358
47	9 0723055	9 9969492	9 0753563	10 9246437	13	0 9276945	.0030508
48	9 0733663	9 9969342	9 0764321	10 9235679	12	0 9266337	.0030658
49	9 0744244	9 9969191	9 0775053	10 9224947	11	0 9255756	.0030809
50	9 0754799	9 9969040	9 0785760	10 9214240	10	0 9245201	.0030960
51	9 0765328	9 9968888	9 0796441	10 9203559	9	0 9234671	.0031112
52	9 0775832	9 9968736	9 0807096	10 9192904	8	0 9224168	.0031264
53	9 0786310	9 9968584	9 0817725	10 9182274	7	0 9213690	.0031416
54	9 0796762	9 9968431	9 0828331	10 9171669	6	0 9203238	.0031569
55	9 0807189	9 9968278	9 0838911	10 9161089	5	0 9192811	.0031722
56	9 0817590	9 9968125	9 0849466	10 9150534	4	0 9182410	.0031875
57	9 0827966	9 9967971	9 0859996	10 9140004	3	0 9172034	.0032029
58	9 0838317	9 9967817	9 0870501	10 9129499	2	0 9161683	.0032183
59	9 0848643	9 9967662	9 0880981	10 9119019	1	0 9151357	.0032338
60	9 0858945	9 9967507	9 0891438	10 9108562	0	0 9141055	.0032493

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
0	9 0858945	9 9967507	9 0891438	10 9108562	60	0 9141055	.0032493
1	9 0869221	9 9967352	9 0901869	10 9098131	59	0 9130779	.0032648
2	9 0879473	9 9967196	9 0912277	10 9087723	58	0 9120527	.0032804
3	9 0889700	9 9967040	9 0922660	10 9077340	57	0 9110306	.0032960
4	9 0899903	9 9966884	9 0933020	10 9066980	56	0 9100097	.0033116
5	9 0910082	9 9966727	9 0943355	10 9056645	55	0 9089918	.0023273
6	9 0920237	9 9966570	9 0953667	10 9046333	54	0 9079763	.0033430
7	9 0930367	9 9966412	9 0963955	10 9036045	53	0 9069633	.0033588
8	9 0940474	9 9966254	9 0974219	10 9025781	52	0 9059526	.0033746
9	9 0950556	9 9966096	9 0984460	10 9015540	51	0 9049444	.0033904
10	9 0960615	9 9965937	9 0994678	10 9005322	50	0 9039385	.0034063
11	9 0970651	9 9965778	9 1004872	10 8995128	49	0 9029349	.0034222
12	9 0980662	9 9965619	9 1015044	10 8984956	48	0 9019338	.0034381
13	9 0990651	9 9965459	9 1025192	10 8974808	47	0 9009349	.0034541
14	9 1000616	9 9965299	9 1035317	10 8964683	46	0 8999384	.0034701
15	9 1010538	9 9965138	9 1045420	10 8954580	45	0 8989442	.0034862
16	9 1020477	9 9964977	9 1055500	10 8944500	44	0 8979523	.0035022
17	9 1030373	9 9964816	9 1065557	10 8934443	43	0 8969627	.0035184
18	9 1040246	9 9964655	9 1075591	10 8924409	42	0 8959754	.0035345
19	9 1050096	9 9964493	9 1085604	10 8914396	41	0 8949904	.0035507
20	9 1059925	9 9964330	9 1095594	10 8904406	40	0 8940076	.0035670
21	9 1069729	9 9964167	9 1105562	10 8894438	39	0 8930271	.0035833
22	9 1079512	9 9964004	9 1115508	10 8884492	38	0 8920488	.0035996
23	9 1089272	9 9963841	9 1125431	10 8874569	37	0 8910728	.0036159
24	9 1099010	9 9963677	9 1135333	10 8864667	36	0 8900990	.0036323
25	9 1108726	9 9963513	9 1145213	10 8854787	35	0 8891274	.0036487
26	9 1118420	9 9963348	9 1155072	10 8844928	34	0 8881580	.0036652
27	9 1128092	9 9963183	9 1164909	10 8835091	33	0 8871908	.0036817
28	9 1137742	9 9963018	9 1174724	10 8825276	32	0 8862258	.0036982
29	9 1147370	9 9962852	9 1184518	10 8815482	31	0 8852630	.0037148
30	9 1156977	9 9962686	9 1194291	10 8805709	30	0 8843023	.0037314

	SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
30	9 1156977	9 9962686	9 1194291	10 8805709	30	0 8843023	.0037314
31	9 1166562	9 9962519	9 1204043	10 8795957	29	0 8833438	.0037481
32	9 1176125	9 9962352	9 1213773	10 8786227	28	0 8823875	.0037648
33	9 1185667	9 9962185	9 1223482	10 8776518	27	0 8814332	.0037815
34	9 1195188	9 9962017	9 1233171	10 8766829	26	0 8804812	.0037983
35	9 1204688	9 9961849	9 1242839	10 8757161	25	0 8795312	.0038151
36	9 1214167	9 9961681	9 1252486	10 8747514	24	0 8785833	.0038319
37	9 1223624	9 9961512	9 1262112	10 8737888	23	0 8776376	.0038488
38	9 1233061	9 9961343	9 1271718	10 8728282	22	0 8766939	.0038657
39	9 1242417	9 9961177	9 1281303	10 8718697	21	0 8757523	.0038826
40	9 1251872	9 9961004	9 1290868	10 8709132	20	0 8748128	.0038996
41	9 1261246	9 9960834	9 1300413	10 8699587	19	0 8738754	.0039166
42	9 1270600	9 9960663	9 1309937	10 8690063	18	0 8729400	.0039337
43	9 1279934	9 9960492	9 1319442	10 8680558	17	0 8720066	.0039508
44	9 1289247	9 9960321	9 1328926	10 8671074	16	0 8710753	.0039679
45	9 1298539	9 9960149	9 1338391	10 8661609	15	0 8701461	.0039851
46	9 1307812	9 9959977	9 1347835	10 8652165	14	0 8692188	.0040023
47	9 1317064	9 9959804	9 1357260	10 8642740	13	0 8682936	.0040196
48	9 1326297	9 9959631	9 1366665	10 8633335	12	0 8673703	.0040369
49	9 1335509	9 9959458	9 1376051	10 8623949	11	0 8664491	.0040542
50	9 1344702	9 9959284	9 1385417	10 8614583	10	0 8655298	.0040716
51	9 1353875	9 9959111	9 1394764	10 8605236	9	0 8646125	.0040889
52	9 1363028	9 9958936	9 1404092	10 8595908	8	0 8636972	.0041064
53	9 1372161	9 9958761	9 1413400	10 8586600	7	0 8627839	.0041239
54	9 1381275	9 9958586	9 1422689	10 8577311	6	0 8618725	.0041414
55	9 1390370	9 9958411	9 1431959	10 8568041	5	0 8609630	.0041589
56	9 1399445	9 9958235	9 1441210	10 8558790	4	0 8600555	.0041765
57	9 1408501	9 9958059	9 1450442	10 8549558	3	0 8591499	.0041941
58	9 1417537	9 9957882	9 1459655	10 8540346	2	0 8582463	.0042118
59	9 1426555	9 9957705	9 1468850	10 8531150	1	0 8573445	.0042295
60	9 1435553	9 9957528	9 1478025	10 8521975	0	0 8564447	.0042472

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 1435553	9 9957528	9 1478025	10 8521975	60	0 8564447	.0042472
1	9 1444532	9 9957350	9 1487182	10 8512818	59	0 8555468	.0042650
2	9 1453493	9 9957172	9 1496321	10 8503679	58	0 8546507	.0042828
3	9 1462435	9 9956993	9 1505441	10 8494559	57	0 8537565	.0043007
4	9 1471358	9 9956815	9 1514543	10 8485457	56	0 8528642	.0043185
5	9 1480262	9 9956635	9 1523627	10 8476373	55	0 8519737	.0043365
6	9 1489148	9 9956456	9 1532692	10 8467308	54	0 8510852	.0043544
7	9 1498015	9 9956276	9 1541739	10 8458261	53	0 8501985	.0043724
8	9 1506864	9 9956095	9 1550769	10 8449231	52	0 8493136	.0043905
9	9 1515693	9 9955915	9 1559780	10 8440220	51	0 8484306	.0044085
10	9 1524507	9 9955734	9 1568773	10 8431227	50	0 8475493	.0044266
11	9 1533301	9 9955552	9 1577748	10 8422252	49	0 8466699	.0044448
12	9 1542076	9 9955370	9 1586706	10 8413294	48	0 8457924	.0044630
13	9 1550834	9 9955188	9 1595646	10 8404354	47	0 8449166	.0044812
14	9 1559574	9 9955005	9 1604569	10 8395431	46	0 8440426	.0044995
15	9 1568296	9 9954822	9 1613473	10 8386527	45	0 8431704	.0045178
16	9 1577000	9 9954639	9 1622361	10 8377639	44	0 8423000	.0045361
17	9 1585686	9 9954455	9 1631231	10 8368769	43	0 8414314	.0045545
18	9 1594354	9 9954271	9 1640083	10 8359917	42	0 8405646	.0045729
19	9 1603005	9 9954087	9 1648919	10 8351081	41	0 8396995	.0045913
20	9 1611639	9 9953902	9 1657737	10 8342263	40	0 8388361	.0046098
21	9 1620254	9 9953717	9 1666538	10 8333462	39	0 8379746	.0046283
22	9 1628853	9 9953531	9 1675322	10 8324678	38	0 8371147	.0046469
23	9 1637434	9 9953345	9 1684089	10 8315911	37	0 8362566	.0046655
24	9 1645998	9 9953159	9 1692839	10 8307161	36	0 8354002	.0046841
25	9 1654544	9 9952972	9 1701572	10 8298428	35	0 8345456	.0047028
26	9 1663074	9 9952785	9 1710289	10 8289711	34	0 8336926	.0047215
27	9 1671586	9 9952597	9 1718989	10 8281011	33	0 8328414	.0047403
28	9 1680081	9 9952409	9 1727672	10 8272328	32	0 8319919	.0047591
29	9 1688559	9 9952221	9 1736338	10 8263662	31	0 8311441	.0047779
30	9 1697021	9 9952033	9 1744988	10 8255612	30	0 8302979	.0047967

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com
30	9 1697021	9 9952	9 1744988	10 8255012	30	0 8302979	.0047967
31	9 1747439	9 9951844	9 1753622	10 8246378	29	0 8294535	.0048156
32	9 1705465	9 9951634	9 1762239	10 8237761	28	0 8286107	.0048346
33	9 1722305	9 9951464	9 1770840	10 8229160	27	0 8277695	.0048536
34	9 1730699	9 9951274	9 1779425	10 8220575	26	0 8269301	.0048726
35	9 1339077	9 9951013	9 1787997	10 8212007	25	0 8260923	.0048916
36	9 1747439	9 9950829	9 1796546	10 8203454	24	0 8252561	.0049107
37	9 1755784	9 9950702	9 1805082	10 8194918	23	0 8244216	.0049298
38	9 1767112	9 9950510	9 1813602	10 8186398	22	0 8235888	.0049490
39	9 1772425	9 9950318	9 1822107	10 8177894	21	0 8227575	.0049682
40	9 1780721	9 9950126	9 1830595	10 8169405	20	0 8219279	.0049874
41	9 1789001	9 9949933	9 1839068	10 8160932	19	0 8210999	.0050067
42	9 1797265	9 9949740	9 1847525	10 8152475	18	0 8202735	.0050260
43	9 1805512	9 9949546	9 1855966	10 8144034	17	0 8194488	.0050454
44	9 1813744	9 9949352	9 1864392	10 8135608	16	0 8186256	.0050648
45	9 1821960	9 9949158	9 1872802	10 8127198	15	0 8178040	.0050842
46	9 1830160	9 9948964	9 1881196	10 8118804	14	0 8169840	.0051036
47	9 1838344	9 9948769	9 1889575	10 8110425	13	0 8161656	.0051231
48	9 1846512	9 9948573	9 1897939	10 8102061	12	0 8153488	.0051427
49	9 1854665	9 9948377	9 1906287	10 8093713	11	0 8145335	.0051623
50	9 1862802	9 9948181	9 1914621	10 8085379	10	0 8137197	.0051819
51	9 1870923	9 9947985	9 1922939	10 8077061	9	0 8129077	.0052015
52	9 1879029	9 9947788	9 1931241	10 8068759	8	0 8120971	.0052212
53	9 1887120	9 9947591	9 1939529	10 8060471	7	0 8112880	.0052409
54	9 1895195	9 9947393	9 1947802	10 8052198	6	0 8104804	.0052607
55	9 1903254	9 9947195	9 1956059	10 8043941	5	0 8096746	.0052805
56	9 1911399	9 9946997	9 1964402	10 8035598	4	0 8088701	.0053003
57	9 1919328	9 9946798	9 1972530	10 8027470	3	0 8080672	.0053202
58	9 1927342	9 9946599	9 1980743	10 8019557	2	0 8072658	.0053401
59	9 1935341	9 9946399	9 1988941	10 8011059	1	0 8064659	.0053601
60	9 1943324	9 9946199	9 1997125	10 8002875	0	0 8056676	.0053801

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M.	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 1943324	9 9946109	9 1997125	10 8002875	60	0 8056676	.0053801
1	9 1951293	9 9945909	9 2005294	10 7994076	59	0 8048707	.0054001
2	9 1959247	9 9945708	9 2013449	10 7986551	58	0 8040753	.0054202
3	9 1967186	9 9945507	9 2021588	10 7978412	57	0 8032814	.0054403
4	9 1975110	9 9945306	9 2029714	10 7970286	56	0 8024860	.0054604
5	9 1983019	9 9945104	9 2037825	10 7962175	55	0 8016381	.0054806
6	9 1990913	9 9944902	9 2045922	10 7954078	54	0 8009087	.0055008
7	9 1998793	9 9944699	9 2054004	10 7945995	53	0 8001207	.0055210
8	9 2006658	9 9944497	9 2062072	10 7937928	52	0 7993342	.0055413
9	9 2014509	9 9944293	9 2070126	10 7929874	51	0 7985491	.0055617
10	9 2022345	9 9944090	9 2078165	10 7921835	50	0 7977655	.0055820
11	9 2030167	9 9943975	9 2086191	10 7913809	49	0 7959833	.0056025
12	9 2037974	9 9943771	9 2094203	10 7905797	48	0 7962026	.0056229
13	9 2045766	9 9943566	9 2102200	10 7897800	47	0 7954234	.0056434
14	9 2053545	9 9943361	9 2110184	10 7889816	46	0 7946455	.0056434
15	9 7061309	9 9943156	9 2118153	10 7881847	45	0 7938691	.0056844
16	9 2069059	9 9942950	9 2126109	10 7873891	44	0 7930941	.0057050
17	9 2076795	9 9942743	9 2134051	10 7865949	43	0 7923205	.0057227
18	9 2084516	9 9942537	9 2141980	10 7858020	42	0 7915484	.0057463
19	9 2092224	9 9942330	9 2149894	10 7850106	41	0 7907776	.0057670
20	9 2099917	9 9942122	9 2157795	10 7842205	40	0 7900083	.0057878
21	9 2107567	9 9941914	9 2165683	10 7834317	39	0 7892403	.0058086
22	9 2115263	9 9941706	9 2173556	10 7826444	38	0 7884737	.0058294
23	9 2122914	9 9941498	9 2181417	10 7818583	37	0 7877086	.0058502
24	9 2130552	9 9941289	9 2189264	10 7810736	36	0 7869448	.0058711
25	9 2138176	9 9941079	9 2197097	10 7802903	35	0 7861824	.0058921
26	9 2145787	9 9940870	9 2204917	10 7795083	34	0 7854213	.0059130
27	9 2153384	9 9940659	9 2212724	10 7787276	33	0 7846616	.0059341
28	9 2160967	9 9940449	9 2220518	10 7779482	32	0 7839033	.0059551
29	9 2168536	9 9940238	9 2228298	10 7771702	31	0 7831464	.0059762
30	9 2176092	9 9940027	9 2236065	10 7763935	30	0 7823908	.0059973

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
30	9 2176 02	9 9940027	9 2236065	10 7763935	30	0 7823908	·0059973
31	9 2183635	9 9939815	9 2243819	10 7756181	29	0 7816305	·0060185
32	9 2191164	9 9939603	9 2251561	10 7748439	28	0 7808836	·0060397
33	9 2198680	9 9939391	9 2259289	10 7740711	27	0 7801320	·0060609
34	9 2206182	9 9939178	9 2267004	10 7732996	26	0 7793818	·0060822
35	9 2213671	9 9938965	9 2274706	10 7725294	25	0 7786329	·0061035
36	9 2221147	9 9938752	9 2282395	10 7717605	24	0 7778853	·0061248
37	9 2228609	9 9938538	9 2290071	10 7709929	23	0 7771391	·0061462
38	9 2236059	9 9938324	9 2297735	10 7702265	22	0 7763941	·0061676
39	9 2243495	9 9938109	9 2305386	10 7694614	21	0 7756505	·0061891
40	9 2250918	9 9937894	9 2313024	10 7686976	20	0 7749082	·0062106
41	9 2258328	9 9937679	9 2320650	10 7679350	19	0 7741672	·0062321
42	9 2265725	9 9937463	9 2328262	10 7671738	18	0 7734275	·0062537
43	9 2273110	9 9937247	9 2335863	10 7664137	17	0 7726890	·0062753
44	9 2280481	9 9937030	9 2343451	10 7656549	16	0 7719519	·0062970
45	9 2287839	9 9936813	9 2351026	10 7648974	15	0 7712161	·0063187
46	9 2295185	9 9936596	9 2358589	10 7641411	14	0 7704815	·0063404
47	9 2302518	9 9936378	9 2366139	10 7633861	13	0 7697482	·0063622
48	9 2309838	9 9936160	9 2373678	10 7626322	12	0 7690162	·0063840
49	9 2317145	9 9935942	9 2381203	10 7618797	11	0 7682855	·0064058
50	9 2324440	9 9935723	9 2388717	10 7611283	10	0 7675560	·0064277
51	9 2331722	9 9935504	9 2396218	10 7603782	9	0 7668278	·0064496
52	9 2338992	9 9935285	9 2403708	10 7596292	8	0 7661008	·0064715
53	9 2346249	9 9935065	9 2411185	10 7588815	7	0 7653751	·0064935
54	9 2353494	9 9934844	9 2418650	10 7581350	6	0 7646506	·0065156
55	9 2360726	9 9934624	9 2426103	10 7573897	5	0 7639274	·0065376
56	9 2367946	9 9934403	9 2433543	10 7566457	4	0 7632054	·0065597
57	9 2375153	9 9934181	9 2440972	10 7559028	3	0 7624847	·0065819
58	9 2382349	9 9933959	9 2448389	10 7551611	2	0 7617651	·0066041
59	9 2389532	9 9933737	9 2455794	10 7544206	1	0 7610468	·0066263
60	9 2396702	9 9933515	9 2463188	10 7536812	0	0 7603298	·0066485

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
0	9 2396722	9 9933515	9 2463188	10 7536812	60	0 7603298	.0066485
1	9 2403061	9 9933292	9 2470569	10 7529431	59	0 7596139	.0066708
2	9 2411007	9 9933008	9 2477939	10 7522061	58	0 7588993	.0066932
3	9 2418141	9 9932845	9 2485297	10 7514703	57	0 7581859	.0067155
4	9 2425264	9 9932621	9 2492643	10 7507357	56	0 7574736	.0067379
5	9 2432374	9 9932395	9 2499978	10 7500022	55	0 7567626	.0067604
6	9 2439472	9 9932171	9 2507301	10 7492699	54	0 7560528	.0067829
7	9 2446558	9 9931946	9 2514612	10 7485388	53	0 7553442	.0068054
8	9 2453632	9 9931720	9 2521912	10 7478088	52	0 7546368	.0068280
9	9 2460695	9 9931494	9 2529200	10 7470800	51	0 7539305	.0068506
10	9 2467746	9 9931268	9 2536477	10 7463523	50	0 7532254	.0068732
11	9 2474785	9 9931041	9 2543743	10 7456257	49	0 7525216	.0068959
12	9 2481811	9 9930814	9 2550997	10 7449003	48	0 7518189	.0069186
13	9 2488827	9 9930587	9 2558240	10 7441760	47	0 7511173	.0069413
14	9 2495830	9 9930359	9 2565472	10 7434528	46	0 7504170	.0069641
15	9 2502822	9 9930131	9 2572692	10 7427308	45	0 7497178	.0069869
16	9 2509803	9 9929902	9 2579901	10 7420099	44	0 7490197	.0070098
17	9 2516772	9 9929673	9 2587099	10 7412901	43	0 7483228	.0070327
18	9 2523729	9 9929444	9 2594285	10 7405715	42	0 7476271	.0070556
19	9 2530675	9 9929214	9 2601461	10 7398539	41	0 7469325	.0070786
20	9 2537609	9 9928984	9 2608625	10 7391375	40	0 7462391	.0071016
21	9 2544532	9 9928753	9 2615779	10 7384221	39	0 7455468	.0071247
22	9 2551444	9 9928522	9 2622921	10 7377079	38	0 7448556	.0071478
23	9 2558344	9 9928291	9 2630053	10 7369947	37	0 7441656	.0071709
24	9 2565233	9 9928059	9 2637173	10 7362827	36	0 7434767	.0071941
25	9 2572110	9 9927827	9 2644283	10 7355717	35	0 7427890	.0072173
26	9 2578977	9 9927595	9 2652382	10 7348618	34	0 7421023	.0072405
27	9 2585832	9 9927362	9 2658470	10 7341530	33	0 7414168	.0072638
28	9 2592676	9 9927129	9 2665547	10 7334453	32	0 7407324	.0072871
29	9 2599509	9 9926895	9 2672613	10 7327387	31	0 7400491	.0073105
30	9 2606330	9 9926661	9 2679669	10 7320331	30	0 7393670	.0073339

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
30	9 2606330	9 9925661	9 2679669	10 7320331	30	0 7393670	.0073339
31	9 2613141	9 9926427	9 2686714	10 7313286	29	0 7386859	.0073573
32	9 2619941	9 9926192	9 2693749	10 7306251	28	0 7380059	.0073808
33	9 2626729	9 9925957	9 2700772	10 7299228	27	0 7373271	.0074043
34	9 2633507	9 9925722	9 2707786	10 7292214	26	0 7366493	.0074278
35	9 2640274	9 9925486	9 2714788	10 7285212	25	0 7359726	.0074514
36	9 2647030	9 9925250	9 2721780	10 7278220	24	0 7352970	.0074750
37	9 2653775	9 9925013	9 2728762	10 7271238	23	0 7346225	.0074987
38	9 2660509	9 9924776	9 2735733	10 7264267	22	0 7339491	.0075224
39	9 2667232	9 9924539	9 2742694	10 7257306	21	0 7332768	.0075461
40	9 2673945	9 9924301	9 2749644	10 7250356	20	0 7326055	.0075699
41	9 2680647	9 9924063	9 2756584	10 7243416	19	0 7319353	.0075937
42	9 2687338	9 9923824	9 2763514	10 7236486	18	0 7312662	.0076176
43	9 2694019	9 9923585	9 2770434	10 7229566	17	0 7305981	.0076415
44	9 2700689	9 9923346	9 2777343	10 7222657	16	0 7299311	.0076654
45	9 2707348	9 9923106	9 2784242	10 7215758	15	0 7292652	.0076894
46	9 2713997	9 9922866	9 2791131	10 7208869	14	0 7286003	.0077134
47	9 2720635	9 9922625	9 2798009	10 7201991	13	0 7279365	.0077374
48	9 2727263	9 9922385	9 2804878	10 7195122	12	0 7272737	.0077615
49	9 2733880	9 9922144	9 2811736	10 7188264	11	0 7266120	.0077856
50	9 2740487	9 9921902	9 2818585	10 7181415	10	0 7259513	.0078098
51	9 2747083	9 9921660	9 2825423	10 7174577	9	0 7252917	.0078340
52	9 2753669	9 9921418	9 2832251	10 7167749	8	0 7246331	.0078582
53	9 2760245	9 9921175	9 2839070	10 7160930	7	0 7239755	.0078825
54	9 2766881	9 9920932	9 2845878	10 7154122	6	0 7233189	.0079068
55	9 2773366	9 9920689	9 2852677	10 7147323	5	0 7226634	.0079311
56	9 2779911	9 9920445	9 2859466	10 7140534	4	0 7220089	.0079555
57	9 2786445	9 9920201	9 2866245	10 7133755	3	0 7213555	.0079799
58	9 2792970	9 9919956	9 2873014	10 7126986	2	0 7207030	.0070044
59	9 2799484	9 9919711	9 2879773	10 7120227	1	0 7200516	.0070289
60	9 2805988	9 9919466	9 2886523	10 7113477	0	0 7194012	.0070534

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
0	9 2805988	9 9919466	9 2886523	10 7113477	60	0 7194012	.0080534
1	9 2812483	9 9919220	9 2893263	10 7106737	59	0 7187517	.0080780
2	9 2818937	9 9918974	9 2899993	10 7100007	58	0 7181033	.0081026
3	9 2825441	9 9918727	9 2906713	10 7093287	57	0 7174559	.0081273
4	9 2831905	9 9918480	9 2913424	10 7086576	56	0 7168095	.0081520
5	9 2838359	9 9918233	9 2920126	10 7079874	55	0 7161641	.0081767
6	9 2844803	9 9917986	9 2926817	10 7073183	54	0 7155197	.0082014
7	9 2851237	9 9917737	9 2933500	10 7066500	53	0 7148763	.0082263
8	9 2857661	9 9917489	9 2940172	10 7059828	52	0 7142339	.0082511
9	9 2864075	9 9917240	9 2946836	10 7053164	51	0 7135924	.0082760
10	9 2870480	9 9916991	9 2953489	10 7046511	50	0 7129520	.0083009
11	9 2876875	9 9916741	9 2960134	10 7039869	49	0 7123125	.0083259
12	9 2883260	9 9916492	9 2966769	10 7033231	48	0 7116740	.0083508
13	9 2889636	9 9916241	9 2973395	10 7026605	47	0 7110364	.0083759
14	9 2896001	9 9915990	9 2980011	10 7019989	46	0 7103999	.0084010
15	9 2902357	9 9915739	9 2986618	10 7013382	45	0 7097643	.0084261
16	9 2908704	9 9915488	9 2993216	10 7006784	44	0 7091296	.0084512
17	9 2915040	9 9915236	9 2999804	10 7000196	43	0 7084960	.0084764
18	9 2921367	9 9914984	9 3006383	10 6993617	42	0 7078633	.0085016
19	9 2927685	9 9914731	9 3012954	10 6987046	41	0 7072315	.0085269
20	9 2933993	9 9914478	9 3019514	10 6980486	40	0 7066007	.0085522
21	9 2940391	9 9214225	9 3026066	10 6973934	39	0 7059709	.0085775
22	9 2946780	9 9913971	9 3032609	10 6967391	38	0 7053420	.0086029
23	9 2952859	9 9913717	9 3039143	10 6960857	37	0 7047141	.0086283
24	9 2959129	9 9913462	9 3045667	10 6954333	36	0 7040871	.0086538
25	9 2965390	9 9913207	9 3052183	10 6947817	35	0 7034610	.0086793
26	9 2971641	9 9912952	9 3058689	10 6941311	34	0 7028359	.0087048
27	9 2977883	9 9912696	9 3065187	10 6934813	33	0 7022117	.0087304
28	9 2984116	9 9912440	9 3071675	10 6928425	32	0 7015884	.0087560
29	9 2990339	9 9912184	9 3078155	10 6921845	31	0 7009661	.0087816
30	9 2996553	9 9911927	9 3084626	10 6915374	30	0 7003447	.0088073

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
30	9 2996553	9 9911427	9 3084626	10 6915374	30	0 7003447	.0088073
31	9 3002758	9 9911670	9 3097541	10 6902459	29	0 6997242	.0088330
32	9 3008953	9 9911412	9 3109541	10 6890459	28	0 6991047	.0088588
33	9 3015140	9 9911154	9 3123985	10 6876015	27	0 6984860	.0088846
34	9 3021317	9 9910896	9 3110421	10 6889579	26	0 6978683	.0089104
35	9 3027485	9 9910637	9 3116848	10 6883152	25	0 6972515	.0089363
36	9 3033644	9 9910378	9 3123266	10 6876734	24	0 6966356	.0089622
37	9 3039794	9 9910119	9 3129675	10 6870325	23	0 6960206	.0089881
38	9 3045934	9 9909859	9 3136076	10 6863924	22	0 6954065	.0090141
39	9 3052066	9 9909598	9 3142468	10 6857532	21	0 6947934	.0090402
40	9 3058188	9 9909338	9 3148851	10 6851149	20	0 6941811	.0090662
41	9 3064303	9 9909077	9 3155226	10 6844774	19	0 6935697	.0090923
42	9 3070407	9 9908815	9 3161592	10 6838408	18	0 6929593	.0091185
43	9 3076503	9 9908553	9 3167950	10 6832050	17	0 6923497	.0091447
44	9 3082590	9 9908291	9 3174299	10 6825701	16	0 6917410	.0091709
45	9 3088668	9 9908029	9 3180640	10 6819360	15	0 6911332	.0091971
46	9 3094737	9 9907766	9 3186971	10 6813028	14	0 6905263	.0092234
47	9 3100798	9 9907502	9 3193295	10 6806705	13	0 6899202	.0092498
48	9 3106849	9 9907239	9 3199611	10 6800389	12	0 6893151	.0092761
49	9 3112892	9 9906974	9 3205918	10 6794082	11	0 6887108	.0093026
50	9 3118926	9 9906710	9 3212217	10 6787784	10	0 6881074	.0093290
51	9 3124951	9 9906445	9 3218506	10 6781494	9	0 6875049	.0093555
52	9 3130968	9 9906180	9 3224788	10 6775212	8	0 6869032	.0093820
53	9 3136976	9 9905914	9 3231061	10 6768939	7	0 6863024	.0094086
54	9 3142975	9 9905648	9 3237327	10 6762673	6	0 6857025	.0094352
55	9 3148965	9 9905382	9 3243584	10 6756416	5	0 6851035	.0094618
56	9 3154949	9 9905115	9 3249832	10 6750168	4	0 6845053	.0094885
57	9 3160921	9 9904848	9 3256073	10 6743927	3	0 6839079	.0095152
58	9 3166885	9 9904580	9 3262305	10 6737695	2	0 6833115	.0095420
59	9 3172841	9 9904312	9 3268529	10 6731471	1	0 6827159	.0095688
60	9 3178789	9 9904044	9 3274745	10 6725255	0	0 6821211	.0095956

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 3178789	9 9904044	9 3274745	10 6725255	60	0 6821211	.0095956
1	9 3184728	9 9903775	9 3280953	10 6719047	59	0 6815272	.0096225
2	9 3190659	9 9903506	9 3287153	10 6712847	58	0 6809341	.0096494
3	9 3190581	9 9903237	9 3293345	10 6706655	57	0 6803419	.0096763
4	9 3202495	9 9902967	9 3299528	10 6700472	56	0 6797505	.0097033
5	9 3208400	9 9902697	9 3305704	10 6694296	55	0 6791600	.0097303
6	9 3214297	9 9902426	9 3311872	10 6688128	54	0 6785703	.0097574
7	9 3220186	9 9902155	9 3318031	10 6681969	53	0 6779814	.0097845
8	9 3226066	9 9901883	9 3324183	10 6675817	52	0 6773934	.0098117
9	9 3231938	9 9901612	9 3330327	10 6669673	51	0 6768062	.0098388
10	9 3237802	9 9901339	9 3336463	10 6663537	50	0 6762198	.0098661
11	9 3243657	9 9901067	9 3342591	10 6657409	49	0 6756343	.0098933
12	9 3249505	9 9900794	9 3348711	10 6651289	48	0 6750495	.0099206
13	9 3255344	9 9900521	9 3354823	10 6645177	47	0 6744656	.0099479
14	9 3261174	9 9900247	9 3360927	10 6639073	46	0 6738826	.0099753
15	9 3266997	9 9899973	9 3367024	10 6632976	45	0 6733003	.0100027
16	9 3272811	9 9899698	9 3373113	10 6626887	44	0 6727189	.0100302
17	9 3278617	9 9899423	9 3379194	10 6620806	43	0 6721383	.0100577
18	9 3284416	9 9899147	9 3385267	10 6614733	42	0 6715584	.0100852
19	9 3290206	9 9898873	9 3391333	10 6608667	41	0 6709794	.0101127
20	9 3295988	9 9898597	9 3397391	10 6602609	40	0 6704012	.0101403
21	9 3301761	9 9898320	9 3403441	10 6596559	39	0 6698239	.0101680
22	9 3307527	9 9898043	9 3409484	10 6590516	38	0 6692473	.0101957
23	9 3313285	9 9897766	9 3415519	10 6584481	37	0 6686715	.0102234
24	9 3319035	9 9897489	9 3421546	10 6578454	36	0 6680965	.0102511
25	9 3324777	9 9897211	9 3427566	10 6572434	35	0 6675223	.0102789
26	9 3330511	9 9896932	9 3433578	10 6566422	34	0 6669489	.0103068
27	9 3336237	9 9896654	9 3439583	10 6560417	33	0 6663763	.0103346
28	9 3341955	9 9896374	9 3445580	10 6554420	32	0 6658045	.0103626
29	9 3347665	9 9896095	9 3451570	10 6548430	31	0 6652335	.0103905
30	9 3353368	9 9895815	9 3457552	10 6542448	30	0 6646632	.0104185

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
30	9 3353368	9 9895815	9 3457552	10 6542448	30	0 6646632	•0104185
31	9 3359062	9 9895535	9 3463527	10 6536473	29	0 6640938	•0104465
32	9 3364749	9 9895254	9 3469494	10 6530506	28	0 6635251	•0104746
33	9 3370428	9 9894973	9 3475454	10 6524546	27	0 6629572	•0105027
34	9 3376099	9 9894692	9 3481407	10 6518593	26	0 6623901	•0105308
35	9 3381762	9 9894410	9 3487352	10 6512648	25	0 6618274	•0105590
36	9 3387418	9 9894128	9 3493290	10 6506710	24	0 6612582	•0105872
37	9 3393065	9 9893845	9 3499226	10 6500780	23	0 6606935	•0106155
38	9 3398706	9 9893562	9 3505143	10 6494857	22	0 6601294	•0106438
39	9 3304338	9 9893279	9 3511059	10 6488941	21	0 6595662	•0106721
40	9 3309963	9 9892995	9 3516968	10 6483032	20	0 6590037	•0107005
41	9 3415580	9 9892711	9 3522869	10 6477131	19	0 6584420	•0107289
42	9 3421190	9 9892427	9 3528763	10 6471237	18	0 6578810	•0107573
43	9 3426792	9 9892142	9 3534650	10 6465350	17	0 6573208	•0107858
44	9 3432386	9 9891856	9 3540530	10 6459470	16	0 6567614	•0108144
45	9 3437973	9 9891571	9 3546402	10 6453598	15	0 6562027	•0108429
46	9 3443552	9 9891285	9 3552267	10 6447733	14	0 6556448	•0108716
47	9 3449124	9 9890998	9 3558126	10 6441874	13	0 6550876	•0109002
48	9 3454688	9 9890711	9 3563977	10 6436023	12	0 6545312	•0109289
49	9 3460245	9 9890424	9 3569821	10 6430179	11	0 6539755	•0109576
50	9 3465794	9 9890137	9 3575658	10 6424342	10	0 6534206	•0109863
51	9 3471336	9 9889849	9 3581487	10 6418513	9	0 6528664	•0110151
52	9 3476870	9 9889560	9 3587310	10 6412690	8	0 6523130	•0110440
53	9 3482397	9 9889271	9 3593126	10 6406874	7	0 6517603	•0110729
54	9 3487917	9 9888982	9 3598935	10 6401065	6	0 6512083	•0111018
55	9 3493429	9 9888693	9 3604736	10 6395264	5	0 6506571	•0111307
56	9 3498934	9 9888403	9 3610531	10 6389469	4	0 6501066	•0111597
57	9 3504432	9 9888113	9 3616319	10 6383681	3	0 6495568	•0111887
58	9 3509922	9 9887822	9 3622100	10 6377900	2	0 6490078	•0112178
59	9 3515405	9 9887531	9 3627874	10 6372126	1	0 6484595	•0112469
60	9 3520880	9 9887239	9 3633641	10 6366359	0	0 6479120	•0112761

SINE Comple-ment.	Sine	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com
0	9 35208 0	9 9887230	9 3633641	10 6366359	60	0 6479120	.0112761
1	9 3526349	9 9886947	9 3639401	10 6360599	59	0 6473651	.0113053
2	9 3531810	9 9886655	9 3645155	10 6354845	58	0 6468190	.0113345
3	9 3537264	9 9886363	9 3650901	10 6349099	57	0 6462736	.0113637
4	9 3542710	9 9886070	9 3656641	10 6343359	56	0 6457290	.0113930
5	9 3548150	9 9885776	9 3662374	10 6337626	55	0 6451850	.0114224
6	9 3553582	9 9885482	9 3668100	10 6331900	54	0 6440418	.0114518
7	9 3559007	9 9885188	9 3673819	10 6326181	53	0 6440993	.0114812
8	9 3564426	9 9884894	9 3679532	10 6320468	52	0 6435574	.0115106
9	9 3569836	9 9884599	9 3685238	10 6314762	51	0 6430164	.0115401
10	9 3575240	9 9884303	9 3690937	10 6309063	50	0 6424760	.0115697
11	9 3580637	9 9884008	9 3696629	10 6303371	49	0 6419363	.0115992
12	9 3586027	9 9883712	9 3702315	10 6297685	48	0 6413973	.0116288
13	9 3591409	9 9883415	9 3707994	10 6292006	47	0 6408591	.0116585
14	9 3596785	9 9883118	9 3713667	10 6286333	46	0 6403215	.0116882
15	9 3602154	9 9882821	9 3719333	10 6280667	45	0 6397846	.0117179
16	9 3607515	9 9882523	9 3724992	10 6275008	44	0 6392485	.0117477
17	9 3612870	9 9882225	9 3730645	10 6269355	43	0 6387130	.0117775
18	9 3618217	9 9881927	9 3736291	10 6263709	42	0 6381783	.0118073
19	9 3623558	9 9881628	9 3741930	10 6258070	41	0 6376442	.0118372
20	9 3628892	9 9881329	9 3747563	10 6252437	40	0 6371108	.0118671
21	9 3634219	9 9881029	9 3753190	10 6246810	39	0 6365781	.0118971
22	9 3639539	9 9880729	9 3758810	10 6241190	38	0 6360461	.0119271
23	9 3644852	9 9880429	9 3764423	10 6235577	37	0 6355148	.0119571
24	9 3650158	9 9880128	9 3770030	10 6229970	36	0 6349842	.0119872
25	9 3655458	9 9879827	9 3775631	10 6224369	35	0 6344542	.0120173
26	9 3660750	9 9879525	9 3781225	10 6218775	34	0 6339250	.0120475
27	9 3666036	9 9879223	9 3786813	10 6213187	33	0 6333964	.0120777
28	9 3671315	9 9878921	9 3792394	10 6207606	32	0 6328685	.0121079
29	9 3676587	9 9878618	9 3797969	10 6202031	31	0 6323413	.0121382
30	9 3681853	9 9878315	9 3803537	10 6196463	30	0 6318147	.0121685

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
30	9 3681853	9 9878315	9 3803537	10 6196463	30	0 6318142	.0121685
31	9 3687111	9 9873012	9 3809109	10 6190909	29	0 6312889	.0121988
32	9 3692363	9 9877708	9 3814655	10 6185345	28	0 6307637	.0722292
33	9 3697608	9 9877404	9 3820205	10 6179795	27	0 6302392	.0122596
34	9 3702847	9 9877099	9 3825748	10 6174252	26	0 6297153	.0122901
35	9 3708079	9 9876794	9 3831285	10 6168715	25	0 6291921	.0123206
36	9 3713304	9 9876488	9 3836816	10 6163184	24	0 6286696	.0123512
37	9 3718523	9 9826183	9 3842340	10 6157660	23	0 6281477	.0123817
38	9 3723735	9 9875876	9 3847858	10 6152142	22	0 6276265	.0124124
39	9 3728940	9 9875570	9 3853370	10 6146630	21	0 6271050	.0124430
40	9 3734139	9 9875263	9 3858876	10 6141124	20	0 6265861	.0124737
41	9 3739331	9 9874955	9 3864376	10 6135624	19	0 6260669	.0125045
42	9 3744517	9 9874648	9 3869869	10 6130131	18	0 6255483	.0125352
43	9 3749696	9 9874339	9 3875356	10 6124644	17	0 6250304	.0125661
44	9 3754868	9 9874031	9 3880837	10 6119163	16	0 6245132	.0125969
45	9 3760034	9 9873722	9 3886312	10 6113688	15	0 6239966	.0126278
46	9 3765194	9 9873413	9 3891781	10 6108219	14	0 6234806	.0126587
47	9 3770347	9 9873103	9 3897244	10 6102756	13	0 6229653	.0126897
48	9 3775493	9 9872793	9 3902700	10 6097300	12	0 6224507	.0127207
49	9 3780633	9 9872482	9 3908151	10 6091849	11	0 6219367	.0127518
50	9 3785767	9 9872171	9 3913595	10 6086405	10	0 6214233	.0127829
51	9 3790894	9 9871860	9 3919034	10 6080966	9	0 6209106	.0128140
52	9 3796015	9 9871545	9 3924466	10 6075534	8	0 6203985	.0128451
53	9 3801129	9 9871236	9 3929893	10 6070107	7	0 6198871	.0128764
54	9 3806237	9 9870924	9 3935313	10 6064687	6	0 6193763	.0129076
55	9 3811339	9 9870611	9 3940727	10 6059273	5	0 6188661	.0129389
56	9 3816434	9 9870298	9 3946136	10 6053864	4	0 6183566	.0129702
57	9 3821523	9 9869984	9 3951538	10 6048462	3	0 6178477	.0130016
58	9 3826605	9 9869670	9 3956935	10 6043065	2	0 6173395	.0130330
59	9 3831682	9 9869356	9 3962326	10 6037674	1	0 6168318	.0130644
60	9 3836752	9 9869041	9 3967711	10 6032289	0	0 6163248	.0130959

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 3835752	9 9869041	9 3967711	10 6032289	60	0 6163248	.0130959
1	9 3841815	9 9868726	9 3973089	10 6026911	59	0 6158185	.0131274
2	9 3846873	9 9868410	9 3978463	10 6021537	58	0 6153127	.0131590
3	9 3851924	9 9868094	9 3983830	10 6016170	57	0 6148076	.0131906
4	9 3856969	9 9867778	9 3989191	10 6010809	56	0 6143031	.0132222
5	9 3862008	9 9867461	9 3994547	10 6005453	55	0 6137992	.0132539
6	9 3867040	9 9867144	9 3999896	10 6000104	54	0 6132960	.0132856
7	9 3872067	9 9866827	9 4005240	10 5994760	53	0 6127933	.0133173
8	9 3877087	9 9866509	9 4010578	10 5989422	52	0 6122913	.0133491
9	9 3882101	9 9866191	9 4015910	10 5984090	51	0 6117899	.0133809
10	9 3887109	9 9865872	9 4021237	10 5978763	50	0 6112891	.0134128
11	9 3892111	9 9865553	9 4026558	10 5973442	49	0 6107889	.0134447
12	9 3897106	9 9865233	9 4031873	10 5968127	48	0 6102894	.0134767
13	9 3902096	9 9864913	9 4037182	10 5962818	47	0 6097904	.0135087
14	9 3907079	9 9864593	9 4042486	10 5957514	46	0 6092921	.0135407
15	9 3912057	9 9864272	9 4047784	10 5952216	45	0 6087943	.0135727
16	9 3917028	9 9863951	9 4053076	10 5946924	44	0 6082972	.0136048
17	9 3921993	9 9863630	9 4058363	10 5941637	43	0 6078007	.0136370
18	9 3926952	9 9863308	9 4063644	10 5936356	42	0 6073048	.0136692
19	9 3931905	9 9862986	9 4068919	10 5931081	41	0 6068095	.0137014
20	9 3936852	9 9862663	9 4074189	10 5925810	40	0 6063148	.0137337
21	9 3941794	9 9862340	9 4079453	10 5920547	39	0 6058206	.0137660
22	9 3946729	9 9862017	9 4084712	10 5915288	38	0 6053271	.0137983
23	9 3951658	9 9861693	9 4089965	10 5910035	37	0 6048342	.0138307
24	9 3956581	9 9861369	9 4095212	10 5904788	36	0 6043419	.0138631
25	9 3961499	9 9861045	9 4100454	10 5899546	35	0 6038501	.0138955
26	9 3966410	9 9860720	9 4105690	10 5894310	34	0 6033590	.0139280
27	9 3971315	9 9860394	9 4110921	10 5889079	33	0 6028685	.0139606
28	9 3976215	9 9860059	9 4116146	10 5883854	32	0 6023785	.0139931
29	9 3981109	9 9859742	9 4121366	10 5878634	31	0 6018891	.0140258
30	9 3985996	9 9859416	9 4126581	10 5873419	30	0 6014004	.0140584

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
30	9 3985996	9 9859416	9 4126581	10 5873419	30	0 6014004	.0140584
31	9 3990878	9 9859089	9 4131789	10 5868211	29	0 6009122	.0140911
32	9 3995754	9 9858762	9 4136993	10 5863007	28	0 6004246	.0141238
33	9 4000625	9 9858434	9 4142191	10 5857809	27	0 5999375	.0141566
34	9 4005489	9 9858106	9 4147383	10 5852617	26	0 5994511	.0141894
35	9 4010348	9 9857777	9 4152570	10 5847430	25	0 5989652	.0142223
36	9 4015201	9 9857449	9 4157752	10 5842248	24	0 5984799	.0142551
37	9 4020048	9 9857119	9 4162928	10 5837072	23	0 5979952	.0142881
38	9 4024889	9 9856790	9 4168099	10 5831901	22	0 5975111	.0143210
39	9 4029734	9 9856490	9 4173265	10 5826735	21	0 5970276	.0143540
40	9 4034554	9 9856129	9 4178425	10 5821575	20	0 5965446	.0143871
41	9 4039378	9 9855798	9 4183580	10 5816420	19	0 5960622	.0144202
42	9 4044196	9 9855467	9 4188729	10 5811271	18	0 5955804	.0144533
43	9 4049009	9 9855135	9 4193874	10 5806126	17	0 5950991	.0144865
44	9 4053816	9 9854803	9 4199013	10 5800987	16	0 5946184	.0145197
45	9 4058617	9 9854471	9 4204146	10 5795854	15	0 5941383	.0145529
46	9 4063413	9 9854138	9 4209274	10 5790725	14	0 5936587	.0145862
47	9 4068203	9 9853805	9 4214398	10 5785602	13	0 5931797	.0146195
48	9 4072987	9 9853471	9 4219515	10 5780485	12	0 5927013	.0146529
49	9 4077766	9 9853138	9 4224628	10 5775372	11	0 5922234	.0146862
50	9 4082539	9 9852803	9 4229735	10 5770265	10	0 5917461	.0147197
51	9 4087306	9 9852468	9 4234833	10 5765162	9	0 5912694	.0147532
52	9 4092068	9 9852133	9 4239935	10 5760665	8	0 5907932	.0147867
53	9 4096824	9 9851798	9 4245026	10 5754974	7	0 5903176	.0148202
54	9 4101575	9 9851462	9 4250113	10 5749887	6	0 5898425	.0148538
55	9 4106320	9 9851125	9 4255194	10 5744806	5	0 5893680	.0148875
56	9 4111059	9 9850789	9 4260271	10 5739729	4	0 5888941	.0149211
57	9 4115793	9 9850452	9 4265342	10 5734658	3	0 5884207	.0149548
58	9 4120522	9 9850114	9 4270408	10 5729592	2	0 5879478	.0149886
59	9 4125245	9 9849776	9 4275469	10 5724531	1	0 5874755	.0150224
60	9 4129962	9 9849438	9 4280525	10 5719475	0	0 5870038	.0150562

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
0	9 4129962	9 9849438	9 4280525	10 5719475	60	0 5870038	.0150562
1	9 4134174	9 9848009	9 4285575	10 5714425	59	0 5865326	.0150901
2	9 4138938	9 9848760	9 4290521	10 5709379	58	0 5860119	.0151240
3	9 4144052	9 9848420	9 4295661	10 5704339	57	0 5855918	.0151580
4	9 4148317	9 9848081	9 4300597	10 5699303	56	0 5851222	.0151919
5	9 4153462	9 9847740	9 4305727	10 5694272	55	0 5846532	.0152260
6	9 4157715	9 9847400	9 4310753	10 5689247	54	0 5841848	.0152600
7	9 4162532	9 9847059	9 4315773	10 5684227	53	0 5837168	.0152941
8	9 4167508	9 9846717	9 4320789	10 5679211	52	0 5832494	.0153283
9	9 4172174	9 9846375	9 4325799	10 5674201	51	0 5827826	.0153625
10	9 4176837	9 9846033	9 4330804	10 5669196	50	0 5823163	.0153970
11	9 4181495	9 9845690	9 4335804	10 5664195	49	0 5818505	.0154310
12	9 4186148	9 9845347	9 4340800	10 5659200	48	0 5813852	.0154653
13	9 4190795	9 9845004	9 4345791	10 5654209	47	0 5809205	.0154996
14	9 4195436	9 9844660	9 4350776	10 5649224	46	0 5804564	.0155340
15	9 4200073	9 9844316	9 4355757	10 5644242	45	0 5799927	.0155684
16	9 4204704	9 9843971	9 4360733	10 5639267	44	0 5795296	.0156029
17	9 4209330	9 9843626	9 4365704	10 5634296	43	0 5790670	.0156374
18	9 4213950	9 9843281	9 4370670	10 5629330	42	0 5786050	.0156719
19	9 4218566	9 9842935	9 4375630	10 5624369	41	0 5781434	.0157065
20	9 4223176	9 9842589	9 4380587	10 5619413	40	0 5776824	.0157411
21	9 4227780	9 9842242	9 4385538	10 5614462	39	0 5772220	.0157758
22	9 4232380	9 9841895	9 4390485	10 5609515	38	0 5767620	.0158105
23	9 4236974	9 9841548	9 4395426	10 5604574	37	0 5763026	.0158452
24	9 4241563	9 9841200	9 4400363	10 5599637	36	0 5758437	.0158800
25	9 4246147	9 9840852	9 4405295	10 5594705	35	0 5753853	.0159148
26	9 4250726	9 9840503	9 4410222	10 5589778	34	0 5749274	.0159497
27	9 4255299	9 9840154	9 4415145	10 5584855	33	0 5744701	.0159846
28	9 4259867	9 9839805	9 4420062	10 5579938	32	0 5740133	.0160195
29	9 4264430	9 9839455	9 4424975	10 5575025	31	0 5735570	.0160545
30	9 4268988	9 9839105	9 4429883	10 5570117	30	0 5731012	.0160895

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith of Sine Com
30	9 4268988	9 9839105	9 4429883	10 5570117	30	0 5731012	.0160895
31	9 4273541	9 9838755	9 4434786	10 5565214	29	0 5726459	.0161245
32	9 4278089	9 9838404	9 4439685	10 5560315	28	0 5721911	.0161596
33	9 4282931	9 9838052	9 4444579	10 5555421	27	6 5717369	.0161948
34	9 4287169	9 9837701	9 4449468	10 5550532	26	0 5712831	.0162299
35	9 4291701	9 9837348	9 4454352	10 5545648	25	0 5708299	.0162652
36	9 4296228	9 9836996	9 4459232	10 5540768	24	0 5703772	.0163004
37	9 4300750	9 9836643	9 4464107	10 5535893	23	0 5699250	.0163357
38	9 4305267	9 9836290	9 4468978	10 5531022	22	0 5694733	.0163710
39	9 4309779	9 9835936	9 4473843	10 5526157	21	0 5690221	.0164064
40	9 4314286	9 9835582	9 4478704	10 5521296	20	0 5685714	.0164418
41	9 4318788	9 9835227	9 4483561	10 5516439	19	0 5681212	.0164773
42	9 4323285	9 9834872	9 4488413	10 5511587	18	0 5676715	.0165128
43	9 4327777	9 9834517	9 4493260	10 5506740	17	0 5672223	.0165483
44	9 4332264	9 9834161	9 4498102	10 5501898	16	0 5667736	.0165839
45	9 4336746	9 9833805	9 4502940	10 5497060	15	0 5663254	.0166195
46	9 4341223	9 9833449	9 4507774	10 5492226	14	0 5658777	.0166551
47	9 4345694	9 9833092	9 4512602	10 5487398	13	0 5654306	.0166908
48	9 4350161	0 9832735	9 4517427	10 5482573	12	0 5649839	.0167265
49	9 4354623	9 9832377	9 4522246	10 5477754	11	0 5645377	.0167623
50	9 4359080	9 9832019	9 4527061	10 5472939	10	0 5640920	.0167981
51	9 4363532	9 9831661	9 4531872	10 5468128	9	0 5636468	.0168339
52	9 4367980	9 9831302	9 4536678	10 5463322	8	0 5632020	.0168698
53	9 4372422	9 9830942	9 4541479	10 5458521	7	0 5627578	.0169058
54	9 4376859	9 9830583	9 4546276	10 5453724	6	0 5623141	.0169417
55	9 4381292	9 9830223	9 4551069	10 5448931	5	0 5618708	.0169777
56	9 4385719	9 9829862	9 4555857	10 5444143	4	0 5614281	.0170138
57	9 4390142	9 9829501	9 4560641	10 5439359	3	0 5609858	.0170499
58	9 4394560	9 9829140	9 4565420	10 5434580	2	0 5605440	.0170860
59	9 4398973	9 9828778	9 4570194	10 5429806	1	0 5601027	.0171222
60	9 4403381	9 9828416	9 4574964	10 5425036	0	0 5696619	.0171586

SINE Complement.	Sine.	Tangent. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 4403181	9 9828416	9 4574961	10 5425036	60	0 5596619	·0171584
1	9 4407784	9 9828054	9 4579730	10 5420270	59	0 5592216	·0171946
2	9 4412182	9 9827691	9 4584491	10 5415509	58	0 5587818	·0172309
3	9 4416576	9 9827328	9 4589248	10 5410752	57	0 5583424	·0172672
4	9 4420965	9 9826964	9 4594001	10 5405999	56	0 5579035	·0173036
5	9 4425349	9 9826600	9 4598749	10 5401251	55	0 5574651	·0173400
6	9 4429728	9 9826236	9 4603492	10 5396508	54	0 5570272	·0173764
7	9 4434103	9 9825871	9 4608232	10 5391768	53	0 5565897	·0174129
8	9 4438472	9 9825506	9 4612967	10 5387033	52	0 5561528	·0174494
9	9 4442837	9 9825140	9 4617697	10 5382303	51	0 5557163	·0174860
10	9 4447197	9 9824774	9 4622423	10 5377577	50	0 5552803	·0175226
11	9 4451553	9 9824408	9 4627145	10 5372855	49	0 5548447	·0175592
12	9 4455904	9 9824041	9 4631863	10 5368137	48	0 5544096	·0175959
13	9 4460250	9 9823674	9 4636576	10 5363424	47	0 5539750	·0176326
14	9 4464591	9 9823306	9 4641285	10 5358715	46	0 5535409	·0176694
15	9 4468927	9 9822938	9 4645990	10 5354010	45	0 5531073	·0177062
16	9 4473259	9 9822569	9 4650690	10 5349310	44	0 5526741	·0177431
17	9 4477586	9 9822201	9 4655386	10 5344614	43	0 5522414	·0177799
18	9 4481909	9 9821831	9 4660078	10 5339922	42	0 5518091	·0178169
19	9 4486227	9 9821462	9 4664765	10 5335235	41	0 5513773	·0178538
20	9 4490540	9 9821092	9 4669448	10 5330552	40	0 5509460	·0178908
21	9 4494849	9 9820721	9 4674127	10 5325873	39	0 5505151	·0179279
22	9 4499153	9 9820351	9 4678802	10 5321198	38	0 5500847	·0179649
23	9 4503452	9 9819979	9 4683473	10 5316527	37	0 5496548	·0180021
24	9 4507747	9 9819608	9 4688139	10 5311861	36	0 5492253	·0180392
25	9 4512037	9 9819236	9 4692801	10 5307199	35	0 5487963	·0180764
26	9 4516322	9 9818863	9 4697459	10 5302541	34	0 5483678	·0181137
27	9 4520603	9 9818490	9 4702112	10 5297888	33	0 5479397	·0181510
28	9 4524879	9 9818117	9 4706762	10 5293238	32	0 5475121	·0181883
29	9 4529151	9 9817744	9 4711407	10 5288593	31	0 5470849	·0182256
30	9 4533418	9 9817370	9 4716048	10 5283952	30	0 5466582	·0182630

SINE Comple-ment.	Sine	TANG. Comple-ment.	Tang.	M

M	Sine	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith of Sine Com
30	9 4533418	9 9817370	9 4716048	10 5283952	30	0 5466582	.0182630
31	9 4537681	9 9816995	9 4720585	10 5279315	29	0 5462319	.0183005
32	9 4541939	9 9816620	9 4725318	10 5274682	28	0 5458061	.0183380
33	9 4546192	9 9816245	9 4729947	10 5270053	27	0 5453808	.0183755
34	9 4550441	9 9815870	9 4734572	10 5265428	26	0 5449559	.0184130
35	9 4554686	9 9815494	9 4739192	10 5260808	25	0 5445314	.0184506
36	9 4558926	9 9815117	9 4743808	10 5256192	24	0 5441074	.0184883
37	9 4563161	9 9814740	9 4748421	10 5251579	23	0 5436839	.0185260
38	9 4567392	9 9814363	9 4753029	10 5246971	22	0 5432608	.0185637
39	9 4571618	9 9813986	9 4757633	10 5242367	21	0 5428382	.0186014
40	9 4575840	9 9813608	9 4762233	10 5237767	20	0 5424160	.0186392
41	9 4580058	9 9813229	9 4766829	10 5233171	19	0 5419942	.0186771
42	9 4584271	9 9812850	9 4771421	10 5228579	18	0 5415729	.0187150
43	9 4588480	9 9812471	9 4776009	10 5223991	17	0 5411520	.0187529
44	9 4592684	9 9812091	9 4780592	10 5219408	16	0 5407316	.0187909
45	9 4596884	9 9811711	9 4785172	10 5214828	15	0 5403116	.0188289
46	9 4601079	9 9811331	9 4789748	10 5210252	14	0 5398921	.0188669
47	9 4605270	9 9810950	9 4794319	10 5205681	13	0 5394730	.0189050
48	9 4609456	0 9810569	9 4798887	10 5201113	12	0 5390544	.0189431
49	9 4613638	9 9810187	9 4803451	10 5196549	11	0 5386362	.0189813
50	9 4617816	9 9809805	9 4808011	10 5191989	10	0 5382184	.0190195
51	9 4621989	9 9809423	9 4812566	10 5187434	9	0 5378011	.0190577
52	9 4626158	9 9809040	9 4817118	10 5182882	8	0 5373842	.0190960
53	9 4630323	9 9808657	9 4821666	10 5178334	7	0 5369677	.0191343
54	9 4634483	9 9808273	9 4826210	10 5173790	6	0 5365517	.0191727
55	9 4638639	9 9807889	9 4830750	10 5169250	5	0 5361361	.0192111
56	9 4642790	9 9807505	9 4835286	10 5164714	4	0 5357210	.0192495
57	9 4646938	9 9807120	9 4839818	10 5160182	3	0 5353062	.0192880
58	9 4651081	9 9806735	9 4844346	10 5155654	2	0 5348919	.0193265
59	9 4655219	9 9806349	9 4848870	10 5151130	1	0 5344781	.0193651
60	9 4659353	9 9805963	9 4853390	10 5146610	0	0 5340647	.0194037

SINE Complement.	Sine.	Tangent. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 4659353	9 9805 96	9 4853390	10 514661	60	0 5340647	.0194037
1	9 4663483	9 9805577	9 4857907	10 5142093	59	0 5336517	.0194423
2	9 4667609	9 9805519	9 4862421	10 5137581	58	0 5332391	.0194810
3	9 4671731	9 9804803	9 4866928	10 5133072	57	0 5328270	.0195197
4	9 4675848	9 9804415	9 4871433	10 5128567	56	0 5324152	.0195585
5	9 4679960	9 9804027	9 4875933	10 5124067	55	0 5320040	.0195973
6	9 4684067	9 9803639	9 4880430	10 5119570	54	0 5315931	.0196361
7	9 4688173	9 9803250	9 4884924	10 5115076	53	0 5311827	.0196750
8	9 4692273	9 9802862	9 4889413	10 5110587	52	0 5307727	.0197140
9	9 4696369	9 9802471	9 4893898	10 5106102	51	0 5303631	.0197529
10	9 4700461	9 9802081	9 4898380	10 5101620	50	0 5299539	.0197919
11	9 4704548	9 9801690	9 4902858	10 5097142	49	0 5295452	.0198310
12	9 4708631	9 9801299	9 4907332	10 5092668	48	0 5291369	.0198701
13	9 4712710	9 9800908	9 4911802	10 5088198	47	0 5287290	.0199092
14	9 4716785	9 9800516	9 4916269	10 5083731	46	0 5283215	.0199484
15	9 4720856	9 9800124	9 4920731	10 5079269	45	0 5279144	.0199876
16	9 4724922	9 9799732	9 4925190	10 5074810	44	0 5275078	.0200268
17	9 4728985	9 9799339	9 4929645	10 5070354	43	0 5271015	.0200661
18	9 4733043	9 9798946	9 4934097	10 5065903	42	0 5266957	.0201054
19	9 4737097	9 9798552	9 4938545	10 5061455	41	0 5262903	.0201448
20	9 4741146	9 9798158	9 4942988	10 5057012	40	0 5258854	.0201842
21	9 4745192	9 9797764	9 4947429	10 5052571	39	0 5254808	.0202236
22	9 4749234	9 9797369	9 4951865	10 5048135	38	0 5250766	.0202631
23	9 4753271	9 9796973	9 4956298	10 5043702	37	0 5246729	.0203027
24	9 4757304	9 9796578	9 4960727	10 5039273	36	0 5242696	.0203422
25	9 4761334	9 9796182	9 4965152	10 5034848	35	0 5238666	.0203818
26	9 4765359	9 9795785	9 4969574	10 5030426	34	0 5234641	.0204215
27	9 4769380	9 9795388	9 4973991	10 5026009	33	0 5230620	.0204612
28	9 4773396	9 9794991	9 4978406	10 5021594	32	0 5226604	.0205009
29	9 4777409	9 9794593	9 4982816	10 5017184	31	0 5222591	.0205407
30	9 4781418	9 9794195	9 4987223	10 5012777	30	0 5218582	.0205805

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
30	9 4781418	9 9794195	9 4987223	10 5002777	30	0 5218582	.0205805
31	9 4785423	9 9793796	9 4991626	10 5008374	29	0 5214577	.0206204
32	9 4789423	9 9793398	9 4996026	10 5003974	28	0 5210577	.0206602
33	9 4793420	9 9792998	9 5000422	10 4999578	27	0 5206580	.0207002
34	9 4797412	9 9792599	9 5004814	10 4995186	26	0 5202588	.0207402
35	9 4801401	9 9792198	9 5009203	10 4990797	25	0 5198599	.0207802
36	9 4805385	9 9791798	9 5013588	10 4986412	24	0 5194615	.0208202
37	9 4809366	9 9791397	9 5017969	10 4982031	23	0 5199634	.0208603
38	9 4813342	9 9790996	9 5022347	10 4977653	22	0 5186658	.0209004
39	9 4817315	9 9790594	9 5026721	10 4973279	21	0 5182685	.0209406
40	9 4821283	9 9790192	9 5031092	10 4968908	20	0 5178717	.0209808
41	9 4825248	9 9789789	9 5035459	10 4964541	19	0 5174752	.0210211
42	9 4829208	9 9789386	9 5039822	10 4960178	18	0 5170792	.0210614
43	9 4833165	9 9788983	9 5044182	10 4955818	17	0 5166835	.0211017
44	9 4837117	9 9788580	9 5048538	10 4951462	16	0 5162883	.0211421
45	9 4841066	9 9788175	9 5052891	10 4947109	15	0 5158934	.0211825
46	9 4845010	9 9787770	9 5057240	10 4942760	14	0 5154990	.0212230
47	9 4848951	9 9787365	9 5061586	10 4938414	13	0 5151049	.0212635
48	9 4852888	9 9786960	9 5065928	10 4934072	12	0 5147112	.0213040
49	9 4856820	9 9786554	9 5070267	10 4929733	11	0 5143180	.0213446
50	9 4860749	9 9786148	9 5074602	10 4925398	10	0 5139251	.0213852
51	9 4864674	9 9785741	9 5078933	10 4921067	9	0 5135326	.0214259
52	9 4868595	9 9785334	9 5083261	10 4916739	8	0 5131405	.0214666
53	9 4872512	9 9784927	9 5087586	10 4912414	7	0 5127488	.0215073
54	9 4876426	9 9784519	9 5091907	10 4908093	6	0 5123574	.0215481
55	9 4880335	9 9784111	9 5096224	10 4903776	5	0 5119665	.0215889
56	9 4884240	9 9783702	9 5100539	10 4899461	4	0 5115760	.0216298
57	9 4888142	9 9783293	9 5104849	10 4895151	3	0 5111858	.0216707
58	9 4892040	9 9782883	9 5109156	10 4890844	2	0 5107960	.0217117
59	9 4895934	9 9782474	9 5113460	10 4886540	1	0 5104066	.0217525
60	9 4899824	9 9782063	9 5117460	10 4882240	0	0 5100176	.0217937

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.	Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 4899824	9 9782063	9 5117760	10 4882240	60 0 5100176	.0217397
1	9 4903710	9 9781653	9 5122057	10 4877943	59 0 5096290	.0218347
2	9 4907592	9 9781241	9 5126351	10 4873649	58 0 5092408	.0218759
3	9 4911471	9 9780830	9 5130541	10 4869359	57 0 5088529	.0219170
4	9 4915345	9 9780418	9 5134927	10 4865073	56 0 5084655	.0219582
5	9 4919216	9 9780006	9 5139210	10 4860790	55 0 5080784	.0219994
6	9 4923083	9 9779593	9 5143490	10 4856510	54 0 5076917	.0220407
7	9 4926946	9 9779180	9 5147766	10 4852234	53 0 5073054	.0220820
8	9 4930806	9 9778766	9 5152039	10 4847961	52 0 5069194	.0221234
9	9 4934661	9 9778353	9 5156309	10 4843691	51 0 5065339	.0221647
10	9 4938513	9 9777938	9 5160575	10 4839425	50 0 5061487	.0222062
11	9 4942361	9 9777523	9 5164838	10 4835162	49 0 5057639	.0222477
12	9 4946205	9 9777108	9 5169097	10 4830903	48 0 5053795	.0222892
13	9 4950046	9 9776693	9 5173353	10 4826647	47 0 5049954	.0223307
14	9 4953883	9 9776277	9 5177606	10 4822394	46 0 5046117	.0223723
15	9 4957716	9 9775860	9 5181855	10 4818145	45 0 5042284	.0224140
16	9 4961545	9 9775444	9 5186101	10 4813899	44 0 5038455	.0224556
17	9 4965370	9 9775026	9 5190344	10 4809656	43 0 5034630	.0224974
18	9 4969192	9 9774609	9 5194583	10 4805417	42 0 5030808	.0225391
19	9 4973010	9 9774191	9 5198819	10 4801181	41 0 5026990	.0225809
20	9 4976824	9 9773772	9 5203052	10 4796948	40 0 5023176	.0226228
21	9 4980635	9 9773354	9 5207282	10 4792718	39 0 5019365	.0226646
22	9 4984442	9 9772934	9 5211508	10 4788492	38 0 5015558	.0227066
23	9 4988245	9 9772515	9 5215730	10 4784270	37 0 5011755	.0227485
24	9 4992045	9 9772095	9 5219950	10 4780050	36 0 5007955	.0227905
25	9 4995840	9 9771674	9 5224166	10 4775834	35 0 5004160	.0228326
26	9 4999633	9 9771253	9 5228379	10 4771621	34 0 5000367	.0228747
27	9 5003421	9 9770832	9 5232589	10 4767411	33 0 4996579	.0229168
28	9 5007206	9 9770410	9 5236795	10 4763205	32 0 4992794	.0229590
29	9 5010987	9 9769988	9 5240999	10 4759001	31 0 4989013	.0230012
30	9 5014764	9 9769566	9 5245199	10 4754801	30 0 4985236	.0230434

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
30	9 5014764	9 9769566	9 5245199	10 4754801	30	0 4985236	.0230434
31	9 5018538	9 9769143	9 5249395	10 4750605	29	0 4981462	.0230857
32	9 5022308	9 9768720	9 5253589	10 4746411	28	0 4977692	.0231280
33	9 5026075	9 9768296	9 5257779	10 4742221	27	0 4973925	.0231704
34	9 5039838	9 9767872	9 5261966	10 4738034	26	0 4970162	.0232128
35	9 5033597	9 9767447	9 5266150	10 4733850	25	0 4966403	.0232553
36	9 5037353	9 9767022	9 5270331	10 4729669	24	0 4962647	.0232978
37	9 5041105	9 9766597	9 5274508	10 4725492	23	0 4958895	.0233403
38	9 5044853	9 9766171	9 5278682	10 4721318	22	0 4955147	.0233829
39	9 5048598	9 9765745	9 5282853	10 4717147	21	0 4951402	.0234255
40	9 5052339	9 9765318	9 5287021	10 4712979	20	0 4947661	.0234682
41	9 5056077	9 9764891	9 5291186	10 4708814	19	0 4943923	.0235109
42	9 5059811	9 9764464	9 5295347	10 4704653	18	0 4940189	.0235536
43	9 5063542	9 9764036	9 5299505	10 4700495	17	0 4936458	.0235964
44	9 5067259	9 9763608	9 5303661	10 4696339	16	0 4932731	.0236392
45	9 5070992	9 9763179	9 5307813	10 4692187	15	0 4929008	.0236820
46	9 5074712	9 9762750	9 5311901	10 4688039	14	0 4925288	.0237250
47	9 5078428	9 9762321	9 5316107	10 4683893	13	0 4921572	.0237679
48	9 5082141	9 9761891	9 5320250	10 4679750	12	0 4917859	.0238109
49	9 5085850	9 9761461	9 5324389	10 4675611	11	0 4914150	.0238539
50	9 5089756	9 9761030	9 5328526	10 4671474	10	0 4910444	.0238970
51	9 5093258	9 9760599	9 5332659	10 4667341	9	0 4906742	.0239401
52	9 5096956	9 9760167	9 5336789	10 4663211	8	0 4903044	.0239833
53	9 5100651	9 9759736	9 5340916	10 4659084	7	0 4899349	.0240264
54	9 5104343	9 9759303	9 5345040	10 4654960	6	0 4895657	.0240697
55	9 5108031	9 9758870	9 5349161	10 4650839	5	0 4891969	.0241130
56	9 5111717	9 9758436	9 5353278	10 4646722	4	0 4888284	.0241563
57	9 5115397	9 9758004	9 5357393	10 4642607	3	0 4884603	.0241996
58	9 5119074	9 9757570	9 5361505	10 4638495	2	0 4880926	.0242430
59	9 5122749	9 9757135	9 5365613	10 4634387	1	0 4877251	.0242865
60	9 5126419	9 9756701	9 5369719	10 4630281	0	0 4873581	.0243299

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.	Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 5126419	9 9756701	9 5369719	10 4630281	60 0 4873581	.0243299
1	9 5130086	9 9756265	9 5373821	10 4626179	59 0 4869914	.0243735
2	9 5133750	9 9755839	9 5377920	10 4622080	58 0 4866250	.0244170
3	9 5147410	9 9755394	9 5382017	10 4617983	57 0 4862590	.0244606
4	9 5141067	9 9754957	9 5386110	10 4613890	56 0 4858933	.0245043
5	9 5144721	9 9754521	9 5390200	10 4609800	55 0 4855279	.0245479
6	9 5148371	9 9754083	9 5394287	10 4605713	54 0 4851629	.0245917
7	9 5152017	9 9753646	9 5398371	10 4601629	53 0 4847983	.0246354
8	9 5155660	9 9753208	9 5402453	10 4597547	52 0 4844340	.0246792
9	9 5159300	9 9752769	9 5406531	10 4593469	51 0 4840700	.0247231
10	9 5162936	9 9752330	9 5410606	10 4589394	50 0 4837064	.0247670
11	9 5166569	9 9751891	9 5414678	10 4585322	49 0 4833431	.0248109
12	9 5170198	9 9751451	9 5418747	10 4581253	48 0 4829802	.0248549
13	9 5173824	9 9751012	9 5422813	10 4577187	47 0 4826176	.0248989
14	9 5177447	9 9750570	9 5426877	10 4573123	46 0 4822553	.0249430
15	9 5181066	9 9750129	9 5430937	10 4569063	45 0 4818934	.0249871
16	9 5184682	9 9749688	9 5434994	10 4565006	44 0 4815318	.0250312
17	9 5188295	9 9749246	9 5439048	10 4560952	43 0 4811705	.0250754
18	9 5191904	9 9748804	9 5443100	10 4556900	42 0 4808096	.0251196
19	9 5195510	9 9748361	9 5447148	10 4552852	41 0 4804490	.0251639
20	9 5199112	9 9747918	9 5451193	10 4548807	40 0 4800888	.0252082
21	9 5202711	9 9747475	9 5455236	10 4544764	39 0 4797289	.0252525
22	9 5206307	9 9747031	9 5459276	10 4540724	38 0 4793693	.0252969
23	9 5209899	9 9746587	9 5463312	10 4536688	37 0 4790101	.0253413
24	9 5213488	9 9746142	9 5467346	10 4533654	36 0 4786512	.0253858
25	9 5217074	9 9745697	9 5471377	10 4528623	35 0 4782926	.0254303
26	9 5220656	9 9745251	9 5475405	10 4524595	34 0 4779344	.0254748
27	9 5224235	9 9744806	9 5479430	10 4520570	33 0 4775765	.0255194
28	9 5227811	9 9744359	9 5483452	10 4516548	32 0 4772189	.0255641
29	9 5231383	9 9743913	9 5487471	10 4512529	31 0 4768617	.0256087
30	9 5234953	9 9743466	9 5491487	10 4508513	30 0 4765047	.0256534

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
30	9 5234953	9 9743466	9 5491487	10 4508513	30	0 4765047	.0256534
31	9 5238518	9 9743018	9 5495500	10 4504500	29	0 4761482	.0256982
32	9 5242081	9 9742570	9 5499511	10 4500489	28	0 4757919	.0257430
33	9 5245640	9 9742122	9 5503519	10 4496481	27	0 4754360	.0257878
34	9 5249196	9 9741673	9 5507523	10 4492477	26	0 4750804	.0258327
35	9 5252749	9 9741224	9 5511525	10 4488475	25	0 4747251	.0258776
36	9 5256298	9 9740774	9 5515524	10 4484479	24	0 4743702	.0259226
37	9 5259844	9 9740324	9 5519521	10 4480479	23	0 4740156	.0259676
38	9 5263387	9 9739873	9 5523514	10 4476486	22	0 4736613	.0260127
39	9 5266927	9 9739422	9 5527504	10 4472496	21	0 4733073	.0260578
40	9 5270463	9 9738971	9 5531492	10 4468508	20	0 4729537	.0261029
41	9 5273997	9 9738519	9 5535477	10 4464523	19	0 4726003	.0261481
42	9 5277526	9 9738067	9 5539459	10 4460541	18	0 4722474	.0261933
43	9 5281053	9 9737615	9 5543438	10 4456562	17	0 4718947	.0262385
44	9 5284577	9 9737162	9 5547415	10 4452585	16	0 4715423	.0262838
45	9 5288097	9 9736709	9 5551388	10 4448612	15	0 4711903	.0263291
46	9 5291614	9 9736255	9 5555359	10 4444641	14	0 4708386	.0263745
47	9 5295128	9 9735801	9 5559327	10 4440673	13	0 4704872	.0264199
48	9 5298638	9 9735346	9 5563292	10 4436708	12	0 4701362	.0264654
49	9 5302146	9 9734891	9 5567255	10 4432745	11	0 4697854	.0265109
50	9 5305650	9 9734435	9 5571214	10 4428786	10	0 4694350	.0265565
51	9 5309151	9 9733980	9 5575171	10 4424829	9	0 4690849	.0266020
52	9 5312649	9 9733523	9 5579125	10 4420875	8	0 4687351	.0266477
53	9 5316143	9 9733067	9 5583077	10 4416923	7	0 4683857	.0266933
54	9 5319635	9 9732610	9 5587025	10 4412975	6	0 4680365	.0267390
55	9 5323123	9 9732152	9 5590971	10 4409029	5	0 4676877	.0267848
56	9 5326608	9 9731694	9 5594914	10 4405086	4	0 4673392	.0268306
57	9 5330090	9 9731236	9 5598854	10 4401146	3	0 4669910	.0268764
58	9 5333569	9 9730777	9 5602792	10 4397208	2	0 4666431	.0269223
59	9 5337044	9 9730318	9 5606727	10 4393273	1	0 4662956	.0269682
60	9 5340517	9 9739858	9 5610659	10 4389341	0	0 4659483	.0270142

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.	Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 5340517	9 9729858	9 5610659	10 4389341	60 0 4656483	.0270142
1	9 5343989	9 9729398	9 5614588	10 4385412	59 0 4656014	.0270602
2	9 5347452	9 9728938	9 5618515	10 4381485	58 0 4652548	.0271062
3	9 5350915	9 9728477	9 5622439	10 4377561	57 0 4649085	.0271523
4	9 5354375	9 9728016	9 5626360	10 4373640	56 0 4645625	.0271984
5	9 5357832	9 9727554	9 5630278	10 4369722	55 0 4142168	.0272446
6	9 5361286	9 9727093	9 5634194	10 4365806	54 0 4638714	.0272908
7	9 5364737	9 9726629	9 5638107	10 4361893	53 0 4635263	.0273371
8	9 5368184	9 9726168	9 5642018	10 4357982	52 0 4631816	.0273832
9	9 5371628	9 9725703	9 5645925	10 4354075	51 0 4628372	.0274297
10	9 5375070	9 9725239	9 5649831	10 4350169	50 0 4624930	.0274761
11	9 5378508	9 9724775	9 5653733	10 4346267	49 0 4621492	.0275225
12	9 5381943	9 9724310	9 5657633	10 4342367	48 0 4618057	.0275690
13	9 5385375	9 9723845	9 5661530	10 4338470	47 0 4614625	.0276155
14	9 5388804	9 9723380	9 5665424	10 4334576	46 0 4611196	.0276620
15	9 5392230	9 9722914	9 5669316	10 4330684	45 0 4607770	.0277086
16	9 5395653	9 9722448	9 5673205	10 4326795	44 0 4604347	.0277552
17	9 5399073	9 9721981	9 5677091	10 4322909	43 0 4600927	.0278019
18	9 5402489	9 9721514	9 5680975	10 4319025	42 0 4597511	.0278486
19	9 5405903	9 9721047	9 5684856	10 4315144	41 0 4594097	.0278953
20	9 5409314	9 9720579	9 5688735	10 4311265	40 0 4590686	.0279421
21	9 5412721	9 9720110	9 5692611	10 4307389	39 0 4587279	.0279890
22	9 5416126	9 9719642	9 5696484	10 4303516	38 0 4583874	.0280358
23	9 5419527	9 9719172	9 5700355	10 4299645	37 0 4580473	.0280828
24	9 5422926	9 9718703	9 5704223	10 4295777	36 0 4577074	.0281297
25	9 5426321	9 9718233	9 5708088	10 4291912	35 0 4573679	.0281767
26	9 5429713	9 9717762	9 5711951	10 4288049	34 0 457 287	.0282238
27	9 5433103	9 9717291	9 5715811	10 4284189	33 0 4569897	.0282709
28	9 5436489	9 9716820	9 5719669	10 4280331	32 0 4563511	.0283180
29	9 5439873	9 9716348	9 5723524	10 4276476	31 0 4560127	.0283652
30	9 5443253	9 9715876	9 5727377	10 4272623	30 0 4556747	.0284124

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
30	9 5442253	9 9715876	9 5727377	10 4272623	30	0 4556747	.0284124
31	9 5446630	9 9715404	9 5731227	10 4268773	29	0 4553370	.0284596
32	9 5450005	9 9714931	9 5735074	10 4264926	28	0 4549995	.0285069
33	9 5453376	9 9714457	9 5738919	10 4261081	27	0 4546624	.0285543
34	9 5456745	9 9713984	9 5742761	10 4257239	26	0 4543255	.0286016
35	9 5460110	9 9713509	9 5746601	10 4253399	25	0 4539890	.0286491
36	9 5463472	9 9713035	9 5750438	10 4249562	24	0 4536528	.0286965
37	9 5466832	9 9712560	9 5754272	10 4245728	23	0 4533168	.0287440
38	9 5470189	9 9712084	9 5758104	10 4241896	22	0 4529811	.0287916
39	9 5473542	9 9711608	9 5761934	10 4238066	21	0 4526458	.0288392
40	9 5476893	9 9711132	9 5765761	10 4234239	20	0 4523107	.0288868
41	9 5480240	9 9710655	9 5769585	10 4230415	19	0 4519760	.0289345
42	9 5483585	9 9710178	9 5773407	10 4226593	18	0 4516415	.0289822
43	9 5486927	9 9709701	9 5777226	10 4222774	17	0 4513073	.0290299
44	9 5490266	9 9709223	9 5781043	10 4218957	16	0 4509734	.0290777
45	9 5493602	9 9708744	9 5784858	10 4215142	15	0 4506398	.0291256
46	9 5496935	9 9708265	9 5788669	10 4211331	14	0 4503065	.0291735
47	9 5500265	9 9707786	9 5792479	10 4207521	13	0 4499735	.0292214
48	9 5503592	9 9707306	9 5796286	10 4203714	12	0 4496408	.0292694
49	9 5506916	9 9706826	9 5800090	10 4199910	11	0 4493084	.0293174
50	9 5510237	9 9706346	9 5803892	10 4196108	10	0 4489763	.0293654
51	9 5513556	9 9705865	9 5807691	10 4192309	9	0 4486444	.0294135
52	9 5516871	9 9705383	9 5811488	10 4188512	8	0 4483129	.0294617
53	9 5520184	9 9704902	9 5815282	10 4184718	7	0 4479816	.0295098
54	9 5523494	9 9704419	9 5819074	10 4180926	6	0 4476506	.0295581
55	9 5526801	9 9703937	9 5822864	10 4177136	5	0 4473199	.0296063
56	9 5530105	9 9703454	9 5826651	10 4173349	4	0 4469895	.0296546
57	9 5533406	9 9702970	9 5830435	10 4169565	3	0 4466594	.0297030
58	9 5536704	9 9702486	9 5834217	10 4165783	2	0 4463296	.0297514
59	9 5539999	9 9702002	9 5837997	10 4162003	1	0 4460001	.0297998
60	9 5543292	9 9701517	9 5841774	10 4158226	00	0 4456708	.0298483

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith.. of Sine..	Compl. Arith. of Sine Com.
0	9 5543292	9 9701517	9 5841774	10 4158226	60	0 4456708	.0298483
1	9 5546581	9 9701032	9 584554.	10 4154451	59	0 4453419	.0298968
2	9 5549868	9 9700547	9 5849321	10 4150679	58	0 4450132	.0299453
3	9 5553152	9 9700061	9 5853091	10 4146909	57	0 4446848	.0299939
4	9 5556433	9 9699574	9 5856859	10 4143141	56	0 4443567	.0300426
5	9 5559711	9 9699087	9 5860624	10 4139376	55	0 4440289	.0300913
6	9 5562989	9 9698600	9 5864386	10 4135614	54	0 4437013	.0301400
7	9 5566259	9 9698112	9 5868147	10 4131853	53	0 4433741	.0301888
8	9 5569529	9 9697624	9 5871904	10 4128096	52	0 4430471	.0302376
9	9 5572796	9 9697136	9 5875660	10 4124340	51	0 4427204	.0302864
10	9 5576060	9 9696647	9 5879413	10 4120587	50	0 4423940	.0303353
11	9 5579321	9 9696158	0 5883163	10 4116837	49	0 4420679	.0303842
12	9 5582579	9 9695668	9 5886912	10 4113088	48	0 4417421	.0304332
13	9 5585835	9 9695177	9 5890657	10 4109343	47	0 4414165	.0304833
14	9 5589088	9 9694687	9 5894401	10 4105599	46	0 4410912	.0305313
15	9 5592338	9 9694196	9 5898142	10 4101858	45	0 4407662	.0305804
16	9 5595585	9 9693704	9 5901881	10 4098119	44	0 4404415	.0306296
17	9 5598829	9 9693212	9 5905617	10 4094383	43	0 4401171	.0306788
18	9 5602071	9 9692720	9 5909351	10 4090649	42	0 4397929	.0307280
19	9 5605310	9 9692227	9 5913082	10 4086918	41	0 4394690	.0307773
20	9 5608546	9 9691734	9 5916812	10 4083188	40	0 4391454	.0308266
21	9 5611779	9 9691241	9 5920539	10 4079461	39	0 4388221	.0308759
22	9 5615010	9 9690746	9 5924263	10 4075737	38	0 4384990	.0309254
23	9 5618237	9 9690252	9 5927985	10 4072015	37	0 4381763	.0309748
24	9 5621462	9 9689757	9 5931705	10 4068295	36	0 4378538	.0310243
25	9 5624685	9 9689262	9 5935423	10 4064577	35	0 4375315	.0310738
26	9 5627904	9 9688766	9 5939138	10 4060862	34	0 4372096	.0311234
27	9 5631121	9 9688270	9 5942851	10 4057145	33	0 4368879	.0311730
28	9 5634335	9 9687773	9 5946561	10 4053439	32	0 4365665	.0312227
29	9 5637546	9 9687276	9 5950269	10 4049731	31	0 4362454	.0312724
30	9 5640754	9 9686779	9 5953975	10 4046025	30	0 4359246	.0313221

SINE Comple-ment.	Sine	TANG. Comple-ment.	Tang.	M

M.	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. rith of Sine Com
30	9 5640754	9 9686779	9 5953975	10 4046025	30	0 4359246	.0313221
31	9 5643960	9 9686281	9 5957679	10 4042321	29	0 4356040	.0313719
32	9 5647163	9 9685783	9 5961380	10 4038620	28	0 4352837	.0314217
33	9 5650363	9 9685284	9 5965079	10 4034921	27	6 4349637	.0314716
34	9 5653561	9 9684785	9 5968776	10 4031224	26	0 4346439	.0315215
35	9 5656756	9 9684286	9 5972470	10 4027530	25	0 4343244	.0315714
36	9 5659948	9 9683786	9 5976162	10 4023838	24	0 4340052	.0316214
37	9 5663137	9 9683285	9 5979852	10 4020148	23	0 4336863	.0316715
38	9 5666324	9 9682784	9 5983540	10 4016460	22	0 4333676	.0317216
39	9 5669508	9 9682283	9 5987225	10 4012775	21	0 4330492	.0317717
40	9 5672689	9 9681781	9 5990908	10 4009092	20	0 4327311	.0318219
41	9 5675868	9 9681279	9 5994588	10 4005412	19	0 4324132	.0318721
42	9 5679044	9 9680777	9 5998267	10 4001733	18	0 4320956	.0319223
43	9 5682217	9 9680274	9 6001943	10 3998057	17	0 4317783	.0319726
44	9 5685387	9 9679771	9 6005617	10 3994383	16	0 4314613	.0320229
45	9 5688555	9 9679267	9 6009289	10 3990711	15	0 4311445	.0320733
46	9 5691721	9 9678763	9 6012958	10 3987042	14	0 4308279	.0321237
47	9 5694883	9 9678258	9 6016625	10 3983375	13	0 4305117	.0321742
48	9 5698043	9 9677753	9 6020290	10 3979710	12	0 4301957	.0322247
49	9 5791200	9 9677247	9 6023953	10 3976047	11	0 4298800	.0322753
50	9 5704355	9 9676741	9 6027613	10 3972387	10	0 4295645	.0323259
51	9 5707506	9 9676235	9 6031271	10 3968729	9	0 4292494	.0323765
52	9 5710656	9 9675728	9 6034937	10 3965073	8	0 4289344	.0324272
53	9 5713802	0 9675221	9 6038581	10 3961419	7	0 4286198	.0324779
54	9 5716946	9 9674713	9 6042233	10 3957767	6	0 4283054	.0325287
55	9 5720087	9 9674205	9 6045882	10 3954118	5	0 4279913	.0325795
56	9 5723226	9 9673697	9 6049529	10 3950471	4	0 4276774	.0326303
57	9 5726362	9 9673188	9 6053174	10 3946826	3	0 4273638	.0326812
58	9 5729495	9 9672679	9 6056817	10 3943183	2	0 4270505	.0327321
59	9 5732626	9 9672169	9 6060457	10 3939543	1	0 4267374	.0327831
60	9 5735754	9 9671659	9 6064096	10 3935904	0	0 4264246	.0328341

SINE Comple-ment.	Sine.	Tangent. Comple-ment.	Tang.	M.

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 5735754	9 9671659	9 6064096	10 3935904	60	0 4264246	·0328341
1	9 5738880	9 9671148	9 6067732	10 3932268	59	0 4261120	·0328852
2	9 5742003	9 9670637	9 6071366	10 3928634	58	0 4257997	·0329363
3	9 5745123	9 9670125	9 6074997	10 3925003	57	0 4254877	·0329875
4	9 5748240	9 9669614	9 6078627	10 3921373	56	0 4251760	·0330386
5	9 5751356	9 9669101	9 6082254	10 3917746	55	0 4248644	·0330899
6	9 5754468	9 9668588	9 6085880	10 3914120	54	0 4245532	·0331412
7	9 5757578	9 9668075	9 6089503	10 3910497	53	0 4242422	·0331925
8	9 5760685	9 9667562	9 6093124	10 3906876	52	0 4239315	·0332438
9	9 5763790	9 9667048	9 6096742	10 3903258	51	0 4236210	·0332952
10	9 5766892	9 9666533	9 6100359	10 3999641	50	0 4233108	·0333467
11	9 5769991	9 9666018	0 6103973	10 3896027	49	0 4230009	·0333982
12	9 5773088	9 9665503	9 6107586	10 3892414	48	0 4226912	·0334497
13	9 5776183	9 9664987	9 6111196	10 3888805	47	0 4223817	·0335013
14	9 5779275	9 9664471	9 6114804	10 3885196	46	0 4220725	·0335529
15	9 5782364	9 9663954	9 6118409	10 3881591	45	0 4217636	·0336046
16	9 5785450	9 9663437	9 6122013	10 3877987	44	0 4214550	·0336563
17	9 5788535	9 9662920	9 6125615	10 3874385	43	0 4211465	·0337080
18	9 5791616	9 9662402	9 6129214	10 3870786	42	0 4208384	·0337598
19	9 5794695	9 9661884	9 6132812	10 3867188	41	0 4205305	·0338116
20	9 5797772	9 9661365	9 6136407	10 3863593	40	0 4202228	·0338635
21	9 5800845	9 9660846	9 6140000	10 3860000	39	0 4199155	·0339154
22	9 5803917	9 9660326	9 6143591	10 3856409	38	0 4196083	·0339674
23	9 5806986	9 9659806	9 6147180	10 3852820	37	0 4193014	·0340194
24	9 5810052	9 9659285	9 6150766	10 3849234	36	0 4189948	·0340715
25	9 5813116	9 9658764	9 6154351	10 3845649	35	0 4186884	·0341236
26	9 5816177	9 9658243	9 6157934	10 3842066	34	0 4183823	·0341757
27	9 5819236	9 9657721	9 6161514	10 3838486	33	0 4180764	·0342279
28	9 5822292	9 9657199	9 6165093	10 3834907	32	0 4177708	·0342801
29	9 5825345	9 9656677	9 6168669	10 3831331	31	0 4174655	·0343323
30	9 5828397	9 9656153	9 6172243	10 3827757	30	0 4171603	·0343847

SINE Comple-ment.	Sine	TANG. Comple-ment.	Tang.	M

M	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith of Sine Com
30	9 5828397	9 9656153	9 6172243	10 3827757	30	0 4171603	·0343847
31	9 5831445	9 9655030	9 6175815	10 3824185	29	0 4168555	·0344370
32	9 5834491	9 9655106	9 6179385	10 3820615	28	0 4165509	·0344894
33	9 5837535	9 9654582	9 6182953	10 3817047	27	6 4162465	·0345418
34	9 5840576	9 9654057	9 6186519	10 3813481	26	0 4159424	·0345943
35	9 5843615	9 9653532	9 6190083	10 3809917	25	0 4156385	·0346468
36	9 5846651	9 9653006	9 6193645	10 3806355	24	0 4153349	·0346994
37	9 5849685	9 9652480	9 6197205	10 3802795	23	0 4150315	·0347520
38	9 5852716	9 9651953	9 6200762	10 3799238	22	0 4147284	·0348047
39	9 5855745	9 9651426	9 6204318	10 3795682	21	0 4144255	·0348574
40	9 5858771	9 9650899	9 6207872	10 3792128	20	0 4141229	·0349101
41	9 5861795	9 9650371	9 6211423	10 3788577	19	0 4138205	·0349629
42	9 5864816	9 9649843	9 6214973	10 3785027	18	0 4135184	·0350157
43	9 5867835	9 9649314	9 6218520	10 3781480	17	0 4132165	·0350686
44	9 5870851	9 9648785	9 6222066	10 3777934	16	0 4129149	·0351215
45	9 5873865	9 9648256	9 6225609	10 3774391	15	0 4126135	·0351744
46	9 5876876	9 9647726	9 6229150	10 3770850	14	0 4123124	·0352274
47	9 5879885	9 9647195	9 6232690	10 3767310	13	0 4120115	·0352805
48	9 5882892	9 9646665	9 6236227	10 3763773	12	0 4117108	·0353335
49	9 5885896	9 9646133	9 6239763	10 3760237	11	0 4114104	·0353867
50	9 5888897	9 9645602	9 6243296	10 3756704	10	0 4111103	·0354398
51	9 5891897	9 9645069	9 6246827	10 3753173	9	0 4108103	·0354931
52	9 5894893	9 9644537	9 6250356	10 3749644	8	0 4105107	·0355463
53	9 5897888	0 9644004	9 6253884	10 3746116	7	0 4102112	·0355996
54	9 5900880	9 9643470	9 6257409	10 3742591	6	0 4099120	·0356530
55	9 5903869	9 9642937	9 6260932	10 3739068	5	0 4096131	·0357063
56	9 5906856	9 9642402	9 6264454	10 3735546	4	0 4093144	·0357598
57	9 5909841	9 9641868	9 6267973	10 3732027	3	0 4090159	·0358132
58	9 5912823	9 9641332	9 6271491	10 3728509	2	0 4087177	·0358668
59	9 5915803	9 9640797	9 6275006	10 3724994	1	0 4084197	·0359203
60	9 5918780	9 9640261	9 6278519	10 3721481	0	0 4081220	·0359739

SINE Comple-ment.	Sine.	Tangent. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com
0	9 5918780	9 9640261	9 6278519	10 3721481	60	0 4081220	.0359739
1	9 5921755	9 9639724	9 6282031	10 3717969	59	0 4078245	.0360276
2	9 5924728	9 9639187	9 6285540	10 3714460	58	0 4075272	.0360813
3	9 5927698	9 9638650	9 6289048	10 3710952	57	0 4072302	.0361350
4	9 5930656	9 9638112	9 6292553	10 3707447	56	0 4069334	.0361888
5	9 5933631	9 9637574	9 6296057	10 3703943	55	0 4066369	.0362426
6	9 5936594	9 9637036	9 6299558	10 3700442	54	0 4063406	.0362964
7	9 5939555	9 9636496	9 6303058	10 3696942	53	0 4060445	.0363504
8	9 5942513	9 9635957	9 6306556	10 3693444	52	0 4057487	.036404
9	9 5945469	9 9635417	9 6310052	10 3689948	51	0 4054531	.0364583
10	9 5948422	9 9634877	9 6313545	10 3686455	50	0 4051578	.0365123
11	9 5951372	9 9634330	9 6317037	10 3682963	49	0 4048527	.0365664
12	9 5954322	9 9633795	9 6320527	10 3679473	48	0 4045678	.0366205
13	9 5957268	9 9633253	9 6324015	10 3675985	47	0 4042732	.0366747
14	9 5960212	9 9632711	9 6327501	10 3672499	46	0 4039788	.0367289
15	9 5963154	9 9632168	9 6330985	10 3669015	45	0 4036846	.0367832
16	9 5966093	9 9631625	9 6334468	10 3665532	44	0 4033907	.0368375
17	9 5969030	9 9631082	9 6337948	10 3662052	43	0 4030970	.0368918
18	9 5971965	9 9630538	9 6341425	10 3658574	42	0 4028035	.0369462
19	9 5974897	9 9629994	9 6344903	10 3655097	41	0 4025103	.0370006
20	9 5977827	9 9629449	9 6348378	10 3651622	40	0 4022173	.0370551
21	9 5980754	9 9628904	9 6351850	10 3648150	39	0 4019246	.0371096
22	9 5983679	9 9628358	9 6355321	10 3644679	38	0 4016321	.0371642
23	9 5986602	9 9627812	9 6358790	10 3641210	37	0 4013398	.0372188
24	9 5989523	9 9627266	9 6362257	10 3637743	36	0 4010477	.0372734
25	9 5992441	9 9626719	9 6365722	10 3634278	35	0 4007559	.0373281
26	9 5995357	9 9626172	9 6369185	10 3630815	34	0 4004643	.0373828
27	9 5998270	9 9625624	9 6372646	10 3627354	33	0 4001730	.0374376
28	9 6001181	9 9625076	9 6376106	10 3623894	32	0 3998819	.0374924
29	9 6004090	9 9624527	9 6379563	10 3620437	31	0 3995910	.0375473
30	9 6006997	9 9623978	9 6383019	10 3616981	30	0 3993003	.0376022

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
30	9 6006997	9 9623978	9 6383019	10 3616981	30	0 3993003	.0376022
31	9 6009901	9 9623428	9 6386473	10 3613527	29	0 3990099	.0376572
32	9 6012803	9 9622878	9 6389925	10 3610075	28	0 3987197	.0377122
33	9 6015703	9 9622328	9 6393375	10 3606625	27	0 3984297	.0377672
34	9 6018600	9 9621777	9 6396823	10 3603177	26	0 3981400	.0378223
35	9 6021495	9 9621226	9 6400269	10 3599731	25	0 3978505	.0378774
36	9 6024388	9 9620974	9 6403714	10 3596286	24	0 3975612	.0379326
37	9 6027278	9 9620122	9 6407156	10 3592844	23	0 3972722	.0379878
38	9 6030166	9 9619569	9 6410597	10 3589403	22	0 3969834	.0380431
39	9 6033052	9 9619016	9 6414036	10 3585964	21	0 3966948	.0380984
40	9 6035936	9 9618463	9 6417473	10 3582527	20	0 3964064	.0381537
41	9 6038817	9 9617909	9 6420908	10 3579092	19	0 3961183	.0382091
42	9 6041696	9 9617355	9 6424342	10 3575658	18	0 3958304	.0382645
43	9 6044573	9 9616800	9 6427773	10 3572227	17	0 3955427	.0383200
44	9 6047448	9 9616245	9 6431203	10 3568797	16	0 3952552	.0383755
45	9 6050320	9 9615689	9 6434631	10 3565369	15	0 3949680	.0384311
46	9 6053190	9 9615133	9 6438057	10 3561943	14	0 3946810	.0384867
47	9 6056057	9 9614576	9 6441481	10 3558519	13	0 3943943	.0385424
48	9 6058923	9 9614020	9 6444903	10 3555097	12	0 3941077	.0385980
49	9 6061786	9 9613463	9 6448324	10 3551676	11	0 3938214	.0386538
50	9 6064647	9 9612904	9 6451743	10 3548257	10	0 3935353	.0387096
51	9 6067506	9 9612346	9 6455160	10 3544840	9	0 3932494	.0387654
52	9 6070362	9 9611787	9 6458575	10 3541425	8	0 3929638	.0388213
53	9 6073216	9 9611228	9 6461988	10 3538012	7	0 3926784	.0388772
54	9 6076068	9 9610668	9 6465400	10 3534600	6	0 3923932	.0389332
55	9 6078918	9 9610108	9 6468810	10 3531190	5	0 3921082	.0389892
56	9 6081765	9 9609548	9 6472217	10 3527783	4	0 3918235	.0390452
57	9 6084611	9 9608987	9 6475624	10 3524376	3	0 3915389	.0391013
58	9 6087454	9 9608426	9 6479028	10 3520972	2	0 3912546	.0391574
59	9 6090294	9 9607864	9 6482431	10 3517569	1	0 3909706	.0392136
60	9 6093133	9 9607302	9 6485831	10 3514169	0	0 3906867	.0392698

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 6093133	9 9607302	9 6485831	10 3514169	60	0 3906867	.0392698
1	9 6095969	9 9606739	9 6489230	10 3510770	59	0 3904031	.0393261
2	9 6098803	9 9606176	9 6492628	10 3507372	58	0 3901197	.0393824
3	9 6101635	9 9605612	9 6496023	10 3503977	57	0 3898365	.0394388
4	9 6104465	9 9605048	9 6499417	10 3500583	56	0 3895535	.0394952
5	9 6107293	9 9604484	9 6502809	10 3497191	55	0 3892707	.0395516
6	9 6110118	9 9603919	9 6506197	10 3493801	54	0 3889882	.0396081
7	9 6112941	9 9603354	9 6509587	10 3490413	53	0 3887059	.0396646
8	9 6115762	9 9602788	9 6512974	10 3487026	52	0 3884238	.0397212
9	9 6118580	9 9602222	9 6516359	10 3483641	51	0 3881420	.0397778
10	9 6121397	9 9601655	9 6519742	10 3480258	50	0 3878603	.0398345
11	9 6124211	9 9601088	0 6523123	10 3476877	49	0 3875789	.0398912
12	9 6127023	9 9600520	9 6526503	10 3473497	48	0 3872977	.0399480
13	9 6129833	9 9599952	9 6529881	10 3470119	47	0 3870167	.0400048
14	9 6132641	9 9599384	9 6533257	10 3466743	46	0 3867359	.0400616
15	9 6135446	9 9598815	9 6536631	10 3463369	45	0 3864554	.0401185
16	9 6138250	9 9598246	9 6540004	10 3459996	44	0 3861750	.0401754
17	9 6141051	9 9597676	9 6543375	10 3456625	43	0 3858949	.0402324
18	9 6143850	9 9597106	9 6546744	10 3453256	42	0 3856150	.0402894
19	9 6146647	9 9596535	9 6550112	10 3449888	41	0 3853353	.0403465
20	9 6149441	9 9595964	9 6553477	10 3446523	40	0 3850559	.0404036
21	9 6152234	9 9595393	9 6556841	10 3443159	39	0 3847766	.0404607
22	9 6155024	9 9594821	9 6560204	10 3439796	38	0 3844976	.0405179
23	9 6157812	9 9594248	9 6563564	10 3436436	37	0 3842188	.0405752
24	9 6160599	9 9593675	9 6566923	10 3433077	36	0 3839401	.0406326
25	9 6163382	9 9593102	9 6570280	10 3429720	35	0 3836618	.0406898
26	9 6166164	9 9592528	9 6573636	10 3426364	34	0 3833836	.0407472
27	9 6168944	9 9591954	9 6576989	10 3423011	33	0 3831056	.0408046
28	9 6171721	9 9591380	9 6580341	10 3419659	32	0 3828279	.0408620
29	9 6174496	9 9590805	9 6583692	10 3416308	31	0 3825504	.0409195
30	9 6177270	9 9590229	9 6587041	10 3412960	30	0 3822730	.0409771

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	9 6177270	9 9590229	9 6587041	10 3412960	30	0 3822730	·0409771
31	9 6180041	9 9589653	9 6590387	10 3409613	29	0 3819959	·0410347
32	9 6182809	9 9589077	9 6593733	10 3406267	28	0 3817191	·0410923
33	9 6185576	9 9588500	9 6597076	10 3402924	27	6 3814424	·0411500
34	9 6188341	9 9587923	9 6600418	10 3399582	26	0 3811659	·0412077
35	9 6191103	9 9587345	9 6603758	10 3396242	25	0 3808897	·0412655
36	9 6193864	9 9586767	9 6607097	10 3392903	24	0 3806136	·0413233
37	9 6196622	9 9586188	9 6610434	10 3389566	23	0 3803378	·0413812
38	9 6199378	9 9585609	9 6613769	10 3386231	22	0 3800022	·0414391
39	9 6202132	9 9585030	9 6617103	10 3382897	21	0 3797868	·0414970
40	9 6204884	9 9584450	9 6620434	10 3379566	20	0 3795116	·0415550
41	9 6207634	9 9583869	9 6623765	10 3376235	19	0 3792366	·0416131
42	9 6210382	9 9583288	9 6627093	10 3372907	18	0 3789618	·0416712
43	9 6213127	9 9582707	9 6630420	10 3369580	17	0 3786873	·0417293
44	9 6215871	9 9582125	9 6633745	10 3366255	16	0 3784129	·0417875
45	9 6218612	9 9581543	9 6637069	10 3362931	15	0 3781388	·0418457
46	9 6221351	9 9580961	9 6640391	10 3359609	14	0 3778649	·0419039
47	9 6224088	9 9580378	9 6643711	10 3356289	13	0 3775912	·0419622
48	9 6226824	9 9579794	9 6647030	10 3352970	12	0 3773176	·0420206
49	9 6229557	9 9579210	9 6650346	10 3349654	11	0 3770443	·0420790
50	9 6232287	9 9578626	9 6653662	10 3346338	10	0 3767713	·0421374
51	9 6235016	9 9578041	9 6656975	10 3343025	9	0 3764984	·0121959
52	9 6237743	9 9577456	9 6660288	10 3339712	8	0 3762257	·0422544
53	9 6240468	0 9576870	9 6663598	10 3336402	7	0 3759532	·0423130
54	9 6243190	9 9576284	9 6666907	10 3333093	6	0 3759810	·0423716
55	9 6245911	9 9575697	9 6670214	10 3329786	5	0 3754089	·0424303
56	9 6248629	9 9575110	9 6673519	10 3326481	4	0 3751371	·0424890
57	9 6251346	9 9574522	9 6676823	10 3323177	3	0 3748654	·0425478
58	9 6254060	9 9573934	9 6680126	10 3319874	2	0 3745940	·0426066
59	9 6256772	9 9573346	9 6683426	10 3316574	1	0 3743228	·0426654
60	9 6259483	9 9572757	9 6680725	10 3313275	0	0 3740517	·0427243

SINE Comple-ment.	Sine.	Tangent. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 6259483	9 9572757	9 6686725	10 3313275	60	0 3740517	·0427243
1	9 6262191	9 9572168	9 6690025	10 3309977	59	0 3737809	·0427832
2	9 6264899	9 9571578	9 6693319	10 3306681	58	0 3735103	·0428422
3	9 6267601	9 9570988	9 6696613	10 3303387	57	0 3732399	·0429012
4	9 6270303	9 9570397	9 6699906	10 3300094	56	0 3729697	·0429603
5	9 6273003	9 9569806	9 6703197	10 3296803	55	0 3726997	·0430194
6	9 6275701	9 9569215	9 6706486	10 3293514	54	0 3724299	·0430785
7	9 6278397	9 9568623	9 6709774	10 3290226	53	0 3721603	·0431377
8	9 6281090	9 9568031	9 6713060	10 3286940	52	0 3718910	·0431970
9	9 6283782	9 9567437	9 6716345	10 3283655	51	0 3716218	·0432563
10	9 6286472	9 9566844	9 6719628	10 3280372	50	0 3713528	·0433156
11	9 6289160	9 9566250	9 6722910	10 3277090	49	0 3710840	·0333750
12	9 6291845	9 9565656	9 6726190	10 3273810	48	0 3708155	·0334344
13	9 6294529	9 9565061	9 6729468	10 3270532	47	0 3705471	·0434939
14	9 6297211	9 9564466	9 6732745	10 3267255	46	0 3702789	·0435534
15	9 6299890	9 9563871	9 6736020	10 3263980	45	0 3700110	·0436130
16	9 6302568	9 9563274	9 6739294	10 3260706	44	0 3697432	·0436726
17	9 6305243	9 9562678	9 6742566	10 3257434	43	0 3694757	·0437322
18	9 6307917	9 9562081	9 6745836	10 3254164	42	0 3692083	·0437919
19	9 6310589	9 9561483	9 6749105	10 3250895	41	0 3689411	·0438517
20	9 6313258	9 9560885	9 6752372	10 3247628	40	0 3686742	·0439110
21	9 6315926	9 9560287	9 6755638	10 3244362	39	0 3684074	·0439713
22	9 6318591	9 9559687	9 6758903	10 3241097	38	0 3681409	·0440311
23	9 6321255	9 9559089	9 6762165	10 3237835	37	0 3678745	·0440911
24	9 6323916	9 9558490	9 6765426	10 3234574	36	0 3676084	·0441510
25	9 6326576	9 9557890	9 6768686	10 3231314	35	0 3673424	·0442110
26	9 6329233	9 9557289	9 6771944	10 3228056	34	0 3670767	·0442711
27	9 6331889	9 9556688	9 6775201	10 3224799	33	0 3668111	·0443312
28	9 6334542	9 9556087	9 6778456	10 3221544	32	0 3665458	·0443913
29	9 6337194	9 9555485	9 6781709	10 3218291	31	0 3662806	·0444515
30	9 6339844	9 9554882	9 6784961	10 3215039	30	0 3660156	·0445118

SINE Comple-ment.	Sine	TANG. Comple-ment.	Tang.	M

M	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	9 6339844	9 9554882	9 6784961	10 3215039	30	0 3660156	.0445118
31	9 6342491	9 9554200	9 6788211	10 3211789	29	0 3657509	.0445720
32	9 6345137	9 9553670	9 6791460	10 3208540	28	0 3654863	.0446324
33	9 6347780	9 9553073	9 6794708	10 3205292	27	0 3652220	.0446927
34	9 6350422	9 9552469	9 6797953	10 3202047	26	0 3649578	.0447531
35	9 6353062	9 9551864	9 6801196	10 3198802	25	0 3646938	.0448136
36	9 6355699	9 9551259	9 6804440	10 3195560	24	0 3644301	.0448741
37	9 6358335	9 9550653	9 6807682	10 3192318	23	0 3641665	.0449347
38	9 6360969	9 9550047	9 6810921	10 3189079	22	0 3639031	.0449953
39	9 6363601	9 9549441	9 6814160	10 3185840	21	0 3636399	.0450559
40	9 6366231	9 9548834	9 6817396	10 3182604	20	0 3633769	.0451166
41	9 6368859	9 9548227	9 6820632	10 3179368	19	0 3631141	.0451773
42	9 6371484	9 9547619	9 6823865	10 3176135	18	0 3628516	.0452381
43	9 6374108	9 9547011	9 6827098	10 3172902	17	0 3625892	.0452989
44	9 6376731	9 9546402	9 6830328	10 3169672	16	0 3623269	.0453598
45	9 6379351	9 9545793	9 6833557	10 3166433	15	0 3620649	.0454207
46	9 6381969	9 9545184	9 6836785	10 3163215	14	0 3618032	.0454816
47	9 6384585	9 9544574	9 6840011	10 3159989	13	0 3615415	.0455426
48	9 6387199	9 9543963	9 6843236	10 3156764	12	0 3612801	.0456037
49	9 6389812	9 9543352	9 6846459	10 3153541	11	0 3610188	.0456648
50	9 6392422	9 9542741	9 6849681	10 3150319	10	0 3607578	.0457253
51	9 6395030	9 9542129	9 6852901	10 3147099	9	0 3604970	.0457871
52	9 6397637	9 9541517	9 6856120	10 3143880	8	0 3602363	.0458483
53	9 6400241	9 9540904	9 6859338	10 3140662	7	0 3599759	.0459096
54	9 6402844	9 9540291	9 6862553	10 3137447	6	0 3597156	.0459709
55	9 6405445	9 9539677	9 6865768	10 3134232	5	0 3594555	.0460323
56	9 6408044	9 9539063	9 6868981	10 3131019	4	0 3591956	.0460937
57	9 6410640	9 9538448	9 6872192	10 3127808	3	0 3589360	.0461552
58	9 6413235	9 9537833	9 6875402	10 3124598	2	0 3586765	.0462167
59	9 6415828	9 9537218	9 6878611	10 3121389	1	0 3584172	.0462782
60	9 6418420	9 9536602	9 6881818	10 3118182	0	0 3581580	.0463398

SINE Comple-ment.	Sine.	Tangent. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 6418420	9 9536602	9 6881818	10 3118182	60	0 3581580	.0463398
1	9 6421009	9 9535985	9 6885023	10 3114977	59	0 3578991	.0464015
2	9 6423596	9 9535369	9 6888227	10 3111773	58	0 3576404	.0464631
3	9 6426182	9 9534751	9 6891430	10 3108570	57	0 3573818	.0465249
4	9 6429765	9 9534134	9 6894631	10 3105369	56	0 3571235	.0465866
5	9 6431347	9 9533515	9 6897831	10 3102169	55	0 3568653	.0466485
6	9 6433926	9 9532897	9 6901030	10 3098970	54	0 3566074	.0467103
7	9 6436504	9 9532278	9 6904226	10 3095774	53	0 3563496	.0467722
8	9 6439080	9 9531658	9 6907422	10 3092578	52	0 3560920	.0468342
9	9 6441654	9 9531038	9 6910616	10 3089384	51	0 3558346	.0468962
10	9 6444226	9 9530418	9 6913809	10 3086191	50	0 3555774	.0469582
11	9 6446796	9 9529797	9 6917000	10 3083000	49	0 3553204	.0470203
12	9 6449365	9 9529175	9 6920189	10 3079811	48	0 3550635	.0470825
13	9 6451931	9 9528553	9 6923378	10 3076622	47	0 3548069	.0471447
14	9 6454496	9 9527931	9 6926565	10 3073435	46	0 3545504	.0472069
15	9 6457058	9 9527308	9 6929750	10 3070250	45	0 3542942	.0472692
16	9 6459619	9 9526685	9 6932934	10 3067066	44	0 3540381	.0473315
17	9 6462178	9 9526061	9 6936117	10 3063883	43	0 3537822	.0473939
18	9 6464735	9 9525437	9 6939298	10 3060702	42	0 3535265	.0474563
19	9 6467290	9 9524813	9 6942478	10 3057522	41	0 3532710	.0475187
20	9 6469844	9 9524188	9 6945656	10 3054344	40	0 3530156	.0475812
21	9 6472395	9 9523562	9 6948833	10 3051167	39	0 3527605	.0476438
22	9 6474945	9 9522936	9 6952009	10 3047991	38	0 3525055	.3477064
23	9 6477492	9 9522310	9 6955183	10 3044817	37	0 3522508	.0477690
24	9 6480038	9 9521683	9 6958355	10 3041645	36	0 3519862	.0478317
25	9 6482582	9 9521055	9 6961527	10 3038473	35	0 3517418	.0478945
26	9 6485124	9 9520428	9 6964697	10 3035303	34	0 3514876	.0479572
27	9 6487665	9 9519799	9 6967865	10 3032135	33	0 3512335	.0480201
28	9 6490203	9 9519171	9 6971032	10 3028968	32	0 3509797	.0480829
29	9 6492740	9 9518541	9 6974198	10 3025802	31	0 3507260	.0481459
30	9 6495274	9 9517912	9 6977363	10 3022637	30	0 3504726	.0482088

	SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith of Sine Com
30	9 6495274	9 9517912	9 6977363	10 3022637	30	0 3504726	.0482088
31	9 6497807	9 9517282	9 6980526	10 3019474	29	0 3502193	.0482718
32	9 6500338	9 9516651	9 6983687	10 3016313	28	0 3499662	.0483349
33	9 6502868	9 9516020	9 6986847	10 3013153	27	0 3497132	.0483980
34	9 6505395	9 9515389	9 6990006	10 3009994	26	0 3494605	.0484611
35	9 6507920	9 9514757	9 6993164	10 3006836	25	0 3492080	.0485243
36	9 6510444	9 9514124	9 6996320	10 3003680	24	0 3489556	.0485875
37	9 6512966	9 9513492	9 6999474	10 3000526	23	0 3487034	.0486508
38	9 6515486	9 9512858	9 7002628	10 2997372	22	0 3484514	.0487142
39	9 6518004	9 9512224	9 7005780	10 2994220	21	0 3481996	.0487776
40	9 6520521	9 9511590	9 7008920	10 2991070	20	0 3479479	.0488410
41	9 6523035	9 9510956	9 7012080	10 2987920	19	0 3476965	.0489044
42	9 6525548	9 9510320	9 7015227	10 2984773	18	0 3474452	.0489680
43	9 6528059	9 9509685	9 7018374	10 2981626	17	0 3471941	.0490315
44	9 6530568	9 9509049	9 7021519	10 2978481	16	0 3469432	.0490951
45	9 6533075	9 9508412	9 7024663	10 2975337	15	0 3466925	.0491588
46	9 6535581	9 9507775	9 7027805	10 2972195	14	0 3464419	.0492225
47	9 6538084	9 9507138	9 7030946	10 2969054	13	0 3461916	.0492862
48	9 6540586	9 9506500	9 7034086	10 2965914	12	0 3459414	.0493500
49	9 6543086	9 9505861	9 7037225	10 2962775	11	0 3456914	.0494139
50	9 6545584	9 9505223	9 7040362	10 2959638	10	0 3454416	.0494777
51	9 6548081	9 9504583	9 7043497	10 2956503	9	0 3451919	.0495417
52	9 6550575	9 9503944	9 7046632	10 2953368	8	0 3449425	.0496056
53	9 6553068	9 9503303	9 7049765	10 2950235	7	0 3446932	.0496697
54	9 6555559	9 9502663	9 7052897	10 2947103	6	0 3444441	.0497337
55	9 6558048	9 9502022	9 7056027	10 2943973	5	0 3441952	.0497978
56	9 6560536	9 9501380	9 7059156	10 2940844	4	0 3439464	.0498620
57	9 6563021	9 9500738	9 7062284	10 2937716	3	0 3436979	.0499262
58	9 6565505	9 9500095	9 7065410	10 2934590	2	0 3434495	.0499905
59	9 6567987	9 9499452	9 7068535	10 2931465	1	0 3432013	.0500548
60	9 6570468	9 9498809	9 7071659	10 2928341	0	0 3429532	.0501191

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 6570468	9 9498809	9 7071659	10 2928341	60	0 3429532	.0501191
1	9 6572946	9 9498165	9 7074781	10 2925219	59	0 3427054	.0501835
2	9 6575423	9 9497521	9 7077902	10 2922098	58	0 3424577	.0502479
3	9 6577898	9 9496876	9 7081022	10 2918978	57	0 3422102	.0503124
4	9 6580371	9 9496230	9 7084141	10 2915859	56	0 3419629	.0503770
5	9 6582842	9 9495585	9 7087258	10 2912742	55	0 3417158	.0504415
6	9 6585312	9 9494938	9 7090374	10 2909626	54	0 3414688	.0505062
7	9 6587780	9 9494292	9 7093488	10 2906512	53	0 3412220	.0505708
8	9 6590246	9 9493645	9 7096601	10 2903399	52	0 3409754	.0506355
9	9 6592710	9 9492997	9 7099713	10 2900287	51	0 3407290	.0507003
10	9 6595173	9 9492349	9 7102824	10 2897176	50	0 3404827	.0507651
11	9 6597634	9 9491700	9 7105933	10 2894067	49	0 3402367	.0508300
12	9 6600093	9 9491051	9 7109041	10 2890959	48	0 3399907	.0508949
13	9 6602550	9 9490402	9 7112148	10 2887852	47	0 3397450	.0509598
14	9 6605005	9 9489752	9 7115254	10 2884746	46	0 3394995	.0510248
15	9 6607459	9 9489101	9 7118358	10 2881642	45	0 3392541	.0510899
16	9 6609911	9 9488450	9 7121461	10 2878539	44	0 3390089	.0511550
17	9 6612361	9 9487799	9 7124562	10 2875438	43	0 3387639	.0512201
18	9 6614810	9 9487147	9 7127662	10 2872338	42	0 3385190	.0512853
19	9 6617257	9 9486495	9 7130761	10 2869239	41	0 3382743	.0513505
20	9 6619702	9 9485842	9 7133859	10 2866141	40	0 3380298	.0514158
21	9 6622145	9 9485189	9 7136956	10 2863044	39	0 3377855	.0514811
22	9 6624586	9 9484535	9 7140051	10 2859949	38	0 3375414	.0515465
23	9 6627026	9 9483881	9 7143145	10 2856855	37	0 3372974	.0516119
24	9 6629464	9 9483227	9 7146237	10 2853763	36	0 3370536	.0516773
25	9 6631900	9 9482572	9 7149329	10 2850671	35	0 3368100	.0517428
26	9 6634335	9 9481916	9 7152419	10 2847581	34	0 3365665	.0518084
27	9 6636768	9 9481260	9 7155508	10 2844492	33	0 3363232	.0518740
28	9 6639199	9 9480604	9 7158595	10 2841405	32	0 3360801	.0519396
29	9 6641628	9 9479947	9 7161682	10 2838318	31	0 3358372	.0520053
30	9 6644056	9 9479289	9 7164767	10 2835233	30	0 3355944	.0520711

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	9 6644056	9 9479289	9 7164767	10 2835233	30	0 3355944	·0520711
31	9 6646482	9 9478631	9 7167851	10 2832149	29	0 3353518	·0521369
32	9 6648906	9 9477973	9 7170933	10 2829067	28	0 3351904	·0522027
33	9 6651329	9 9477314	9 7174014	10 2825986	27	6 3348671	·0522686
34	9 6653749	9 9476655	9 7177094	10 2822906	26	0 3346251	·0523345
35	9 6656168	9 9475995	9 7180173	10 2819827	25	0 3343832	·0524005
36	9 6658586	9 9475335	9 7183251	10 2816749	24	0 3341414	·0524665
37	9 6661001	9 9474674	9 7186327	10 2813673	23	0 3338999	·0525326
38	9 6663415	9 9474013	9 7189402	10 2810598	22	0 3336585	·0525987
39	9 6665828	9 9473352	9 7192476	10 2807524	21	0 3334172	·0526648
40	9 6668238	9 9472689	9 7195549	10 2804451	20	0 3331762	·0527311
41	9 6670647	9 9472027	9 7198620	10 2801380	19	0 3329353	·0527973
42	9 6673054	9 9471364	9 7201690	10 2798309	18	0 3326946	·0528636
43	9 6675459	9 9470700	9 7204759	10 2795241	17	0 3324541	·0529300
44	9 6677863	9 9470036	9 7207827	10 2792173	16	0 3322137	·0529964
45	9 6680265	9 9469372	9 7210893	10 2789107	15	0 3319735	·0530628
46	9 6682665	9 9468707	9 7213958	10 2786042	14	0 3317335	·0531293
47	9 6685064	9 9468042	9 7217022	10 2782978	13	0 3314936	·0531958
48	9 6687461	9 9467376	9 7220085	10 2779915	12	0 3312539	·0532624
49	9 6689856	9 9466710	9 7223147	10 2776853	11	0 3310144	·0533290
50	9 6692250	9 9466043	9 7226207	10 2773793	10	0 3307750	·0533957
51	9 6694642	9 9465336	9 7229266	10 2770734	9	0 3305358	·0534624
52	9 6697032	9 9464708	9 7232324	10 2767676	8	0 3302968	·0535292
53	9 6699420	9 9464040	9 7235381	10 2764619	7	0 3300580	·0535960
54	9 6701807	9 9463371	9 7238436	10 2761564	6	0 3298193	·0536629
55	9 6704192	9 9462702	9 7241490	10 2758510	5	0 3295808	·0537298
56	9 6706576	9 9462032	9 7244543	10 2755457	4	0 3293424	·0537968
57	9 6708958	9 9461362	9 7247595	10 2752405	3	0 3291042	·0538638
58	9 6711438	9 9460692	9 7250646	10 2749354	2	0 3288662	·0539308
59	9 6713716	9 9460021	9 7253695	10 2746305	1	0 3286284	·0539979
60	9 6716093	9 9469349	9 7256744	10 2743256	0	0 3283907	·0530651

SINE Comple-ment.	Sine.	Tangent. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 6716093	9 9459349	9 7256744	10 2743256	60	0 3283907	.0540651
1	9 6718468	9 9458077	9 7259711	10 2740209	59	0 3281522	.0541323
2	9 6720841	9 9458005	9 7262837	10 2737163	58	0 3279159	.0541995
3	9 6723212	9 9457332	9 7268881	10 2734119	57	0 3276787	.0542668
4	9 6725583	9 9456659	9 7268925	10 2731075	56	0 3274417	.0543341
5	9 6727952	9 9455985	9 7271967	10 2728033	55	0 3272048	.0544015
6	9 6730319	9 9455310	9 7275008	10 2724992	54	0 3269681	.0544690
7	9 6732684	9 9454636	9 7278048	10 2721952	53	0 3267316	.0545364
8	9 6735047	9 9453960	9 7281087	10 2718913	52	0 3264953	.0546040
9	9 6737409	9 9453285	9 7284124	10 2715876	51	0 3262591	.0546715
10	9 6739769	9 9452609	9 7287161	10 2712839	50	0 3260231	.0547391
11	9 6742128	9 9451932	9 7290196	10 2709804	49	0 3257872	.0548068
12	9 6744485	9 9451255	9 7293230	10 2706770	48	0 3255515	.0548745
13	9 6746840	9 9450577	9 7296263	10 2703737	47	0 3253160	.0549423
14	9 6749194	9 9449899	9 7299295	10 2700705	46	0 3250806	.0550101
15	9 6751546	9 9449220	9 7302325	10 2697675	45	0 3248454	.0550980
16	9 6753896	9 9448541	9 7305354	10 2694646	44	0 3246104	.0551459
17	9 6756245	9 9447862	9 7308383	10 2691617	43	0 3243756	.0552138
18	9 6758592	9 9447182	9 7311410	10 2688590	42	0 3241408	.0552818
19	9 6760937	9 9446501	9 7314436	10 2685564	41	0 3239063	.0553499
20	9 6763281	9 9445821	9 7317460	10 2682540	40	0 3236719	.0554179
21	9 6765623	9 9445139	9 7320484	10 2679516	39	0 3234 77	.0554861
22	9 6767963	9 9444457	9 7323506	10 2676494	38	0 3232037	.0555543
23	9 6770302	9 9443775	9 7326527	10 2673473	37	0 3229698	.0556225
24	9 6772640	9 9443092	9 7329547	10 2670453	36	0 3227360	.0556908
25	9 6774975	9 9442409	9 7332566	10 2667434	35	0 32250 5	.0557591
26	9 6777309	9 9441725	9 7335584	10 2664416	34	0 3222 91	.0558275
27	9 6779642	9 9441041	9 7338601	10 2661399	33	0 3220358	.0558959
28	9 6781972	9 9440356	9 7341616	10 2658384	32	0 3218028	.0559644
29	9 6784301	9 9439671	9 7344631	10 2655369	31	0 3215699	.0560329
30	9 6786629	9 9438985	9 7347644	10 2652356	30	0 3213371	.0561015

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	9 6786629	9 9438985	9 7317644	10 2652356	30	0 3213371	·0561015
31	9 6788955	9 9438299	9 7350656	10 2649344	29	0 3211045	·0561701
32	9 6791279	9 9437612	9 7353267	10 2646333	28	0 3218721	·0562388
33	9 6793602	9 9436925	9 7356677	10 2643323	27	6 3206398	·0563075
34	9 6795923	9 9436238	9 7359685	10 2640315	26	0 3204077	·0563762
35	9 6798243	9 9435549	9 7362693	10 2637307	25	0 3201757	·0564451
36	9 6800560	9 9434861	9 7365699	10 2634361	24	0 3199440	·0565139
37	9 6802877	9 9434172	9 7368705	10 2631295	23	0 3197123	·0565828
38	9 6805191	9 9433482	9 7371309	10 2628291	22	0 3194809	·0566518
39	9 6807504	9 9432792	9 7374712	10 2625288	21	0 3192496	·0567208
40	9 6809816	9 9432102	9 7377714	10 2622286	20	0 3190184	·0567898
41	9 6812126	9 9431411	9 7380715	10 2619285	19	0 3187874	·0568589
42	9 6814434	9 9430720	9 7383714	10 2616286	18	0 3185565	·0569280
43	9 6816741	9 9430028	9 7386713	10 2613287	17	0 3183259	·0569972
44	9 6819046	9 9429335	9 7389710	10 2610290	16	0 3180954	·0570665
45	9 6821349	9 9428643	9 7392707	10 2607293	15	0 3178651	·0571357
46	9 6823651	9 9427949	9 7395702	10 2604298	14	0 3176349	·0572051
47	9 6825952	9 9427255	9 7398696	10 2601304	13	0 3174048	·0572745
48	9 6828250	9 9426561	9 7401689	10 2598311	12	0 3171750	·0573439
49	9 6830548	9 9425866	9 7404681	10 2595319	11	0 3169452	·0574134
50	9 6832843	9 9425171	9 7407672	10 2592328	10	0 3167157	·0574829
51	9 6835137	9 9424475	9 7410662	10 2589338	9	0 3164863	·0575524
52	9 6837430	9 9423779	9 7413650	10 2586350	8	0 3162570	·0576221
53	9 6839720	0 9423083	9 7416638	10 2583362	7	0 3160280	·0576917
54	9 6842010	9 9422386	9 7419624	10 2580376	6	0 3157990	·0577624
55	9 6844297	9 9421688	9 7422609	10 2577391	5	0 3155703	·0578312
56	9 6846583	9 9420990	9 7425594	10 2574406	4	0 3153417	·0579010
57	9 6848868	9 9420291	9 7428577	10 2571423	3	0 3151132	·0579709
58	9 6851151	9 9419592	9 7431559	10 2568441	2	0 3148849	·0580408
59	9 6853432	9 9418893	9 7434540	10 2565460	1	0 3146568	·0581107
60	9 6855712	9 9418193	9 7437520	10 2562480	0	0 3144288	·0581807

SINE Complement.	Sine.	Tangent. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 6855712	9 9418192	9 743752	10 2562480	60	0 3144288	.0581807
1	9 6857991	9 9417402	9 7440499	10 2559501	59	0 3142009	.0582508
2	9 6860267	9 9416791	9 7443476	10 2556524	58	0 3139733	.0583209
3	9 6862542	9 9416090	9 7446453	10 2553547	57	0 3137458	.0583910
4	9 6864816	9 9415388	9 7449428	10 2550572	56	0 3135184	.0584612
5	9 6867088	9 9414685	9 7452403	10 2547597	55	0 3132912	.0585315
6	9 6869359	9 9413982	9 7455376	10 2544624	54	0 3130641	.0586018
7	9 6871628	9 9413279	9 745834	10 2541651	53	0 3128372	.0586721
8	9 6873895	9 9412575	9 7461320	10 2538680	52	0 3126105	.0587425
9	9 6876161	9 9411871	9 7464290	10 2535710	51	0 3123839	.0588129
10	9 6878425	9 9411166	9 7467259	10 2532741	50	0 3121575	.0588834
11	9 6880688	9 9410461	9 7470227	10 2529773	49	0 3119312	.0589539
12	9 6882949	9 9409755	9 7473194	10 2526806	48	0 3117051	.0590245
13	9 6885209	9 9409048	9 7476160	10 2523840	47	0 3114791	.0590952
14	9 6887467	9 9408342	9 7479125	10 2520875	46	0 3112533	.0591658
15	9 6889723	9 9407634	9 7482089	10 2517911	45	0 3110277	.0592366
16	9 6891978	9 9406927	9 7485052	10 2514948	44	0 3108022	.0593073
17	9 6894232	9 9406219	9 7488013	10 2511987	43	0 3105768	.0593781
18	9 6896484	9 9405510	9 7490974	10 2509026	42	0 3103516	.0594490
19	9 6898734	9 9404801	9 7493934	10 2506066	41	0 3101266	.0595199
20	9 6900983	9 9404091	9 7496892	10 2503108	40	0 3099017	.0595909
21	9 6903231	9 9403381	9 7499850	10 2500150	39	0 3096769	.0596619
22	9 6905476	9 9402670	9 7502800	10 2497194	38	0 3094524	.0597330
23	9 6907721	9 9401959	9 7505762	10 2494238	37	0 3092279	.0598041
24	9 6909964	9 9401248	9 7508716	10 2491284	36	0 3090036	.0598752
25	9 6912205	9 9400535	9 7511669	10 2488331	35	0 3087795	.0599465
26	9 6914445	9 9399823	9 7514622	10 2485378	34	0 3085555	.0600177
27	9 6916683	9 939911	9 7517573	10 2482427	33	0 3083317	.0600890
28	9 6918919	9 9398396	9 7520523	10 2479477	32	0 3081081	.0601604
29	9 6921155	9 9397682	9 7523472	10 2476528	31	0 3078845	.0602318
30	9 6923388	9 9396968	9 7526420	10 2473580	30	0 3076612	.0603032

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com.
30	9 6923388	9 9396963	9 7526420	10 2473580	30	0 3076612	.0603032
31	9 6925620	9 9396253	9 7529367	10 2470632	29	0 3074380	.0603747
32	9 6927851	9 9395537	9 7532314	10 2467686	28	0 3072149	.0604463
33	9 6930080	9 9394821	9 7535259	10 2464741	27	0 3069920	.0605179
34	9 6932308	9 9394105	9 7538203	10 2461797	26	0 3067692	.0605895
35	9 6934534	9 9393383	9 7541146	10 2458854	25	0 3065466	.0606612
36	9 6936758	9 9392671	9 7544088	10 2455912	24	0 3063242	.0607329
37	9 6938981	9 9391953	9 7547029	10 2452971	23	0 3061019	.0608047
38	9 6941203	9 9391234	9 7549969	10 2450031	22	0 3058797	.0608766
39	9 6943423	9 9390515	9 7552908	10 2447092	21	0 3056577	.0609485
40	9 6945642	9 9389796	9 7555846	10 2444154	20	0 3054358	.0610204
41	9 6947859	9 9389076	9 7558783	10 2441217	19	0 3052141	.0610924
42	9 6950074	9 9388356	9 7561718	10 2438282	18	0 3049926	.0611644
43	9 6952288	9 9387635	9 7564653	10 2435347	17	0 3047712	.0612365
44	9 6954501	9 9386914	9 7567587	10 2432413	16	0 3045499	.0613086
45	9 6956712	9 9386192	9 7570520	10 2429480	15	0 3043288	.0613808
46	9 6958922	9 9385470	9 7573452	10 2426548	14	0 3041078	.0614530
47	9 6961130	9 9384747	9 7576383	10 2423617	13	0 3038870	.0615253
48	9 6963336	9 9384024	9 7579313	10 2420687	12	0 3036664	.0615976
49	9 6965541	9 9383300	9 7582242	10 2417758	11	0 3034456	.0616700
50	9 6967745	9 9382576	9 7585170	10 2414830	10	0 3032255	.0617424
51	9 6969947	9 9381851	9 7588096	10 2411904	9	0 3030053	.0618149
52	9 6972148	9 9381126	9 7591022	10 2408978	8	0 3027852	.0618874
53	9 6974347	9 9380400	9 7593947	10 2406053	7	0 3025653	.0619600
54	9 6976545	9 9379674	9 7596871	10 2403129	6	0 3023455	.0620325
55	9 6978741	9 9378947	9 7599794	10 2400206	5	0 3021250	.0621053
56	9 6980936	9 9378220	9 7602716	10 2397284	4	0 3019064	.0621780
57	9 6983129	9 9377492	9 7605637	10 2394363	3	0 3016871	.0622508
58	9 6985321	9 9376764	9 7608557	10 2391443	2	0 3014679	.0623236
59	9 6987511	9 9376035	9 7611476	10 2388524	1	0 3012489	.0623965
60	9 6989700	9 9375306	9 7614394	10 2385606	0	0 3010300	.0624694
	SINE Complement.	Sine.	TANG. Complement.	Tang.	M		

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 6989700	9 9375306	9 7614394	10 2385606	60	0 3010300	.0624694
1	9 6991887	9 9374577	9 7617311	10 2382689	59	0 3008113	.0625423
2	9 6994073	9 9373847	9 7620227	10 2379773	58	0 3005927	.0626153
3	9 6996258	9 9373116	9 7623142	10 2376858	57	0 3003742	.0626884
4	9 6998441	9 9372385	9 7626056	10 2373944	56	0 3001559	.0627615
5	9 7000622	9 9371653	9 7628969	10 2371031	55	0 2999378	.0628347
6	9 7002802	9 9370921	9 7631881	10 2368119	54	0 2997198	.0629079
7	9 7004981	9 9370189	9 7634792	10 2365208	53	0 2995019	.0629811
8	9 7007159	9 9369455	9 7637702	10 2362298	52	0 2992842	.0630544
9	9 7009334	9 9368722	9 7640612	10 2359388	51	0 2990666	.0631278
10	9 7011508	9 9367988	9 7643520	10 2356480	50	0 2988492	.0632012
11	9 7013681	9 9367254	9 7646427	10 2353573	49	0 2986319	.0632746
12	9 7015852	9 9366519	9 7649334	10 2350666	48	0 2984148	.0633481
13	9 7018002	9 9365783	9 7652239	10 2347761	47	0 2981978	.0634217
14	9 7020190	9 9365047	9 7655143	10 2344857	46	0 2979810	.0634953
15	9 7022357	9 9364311	9 7658047	10 2341953	45	0 2977943	.0635689
16	9 7024523	9 9363574	9 7660949	10 2339051	44	0 2975477	.0636426
17	9 7026687	9 9362836	9 7663851	10 2336149	43	0 2973313	.0637164
18	9 7028849	9 9362098	9 7666751	10 2333249	42	0 2971151	.0637902
19	9 7031011	9 9361360	9 7669651	10 2330349	41	0 2968989	.0638640
20	9 7033170	9 9360621	9 7672550	10 2327450	40	0 2966830	.0639379
21	9 7035329	9 9359881	9 7675448	10 2324552	39	0 2964671	.0640119
22	9 7037486	9 9359141	9 7678344	10 2321656	38	0 2962514	.0640859
23	9 7039641	9 9358401	9 7681240	10 2318760	37	0 2960359	.0641599
24	9 7041795	9 9357660	9 7684135	10 2315865	36	0 2958205	.0642340
25	9 7043947	9 9356918	9 7687029	10 2312971	35	0 2956053	.0643082
26	9 7046099	9 9356177	9 7689922	10 2310078	34	0 2953901	.0643823
27	9 7048248	9 9355434	9 7692814	10 2307186	33	0 2951752	.0644566
28	9 7050397	9 9354691	9 7695705	10 2304295	32	0 2949603	.0645309
29	9 7052543	9 9353948	9 7698595	10 2301404	31	0 2947457	.0646052
30	9 7054689	9 9353204	9 7701485	10 2298515	30	0 2945311	.0646796

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.	Compl. Arith. of of Sine.	Compl. Arith. of Sine Com.
30	9 7054689	9 9353204	9 7701485	10 2298515	30 0 2945311	.0646796
31	9 7056833	9 9352459	9 7704373	10 2295627	29 0 2943167	.0647541
32	9 7058973	9 9351715	9 7707261	10 2292739	28 0 2941025	.0648285
33	9 7061116	9 9350969	9 7710147	10 2289853	27 0 2938884	.0649031
34	9 7063256	9 9350223	9 7713033	10 2286967	26 0 2936744	.0649777
35	9 7065394	9 9349477	9 7715917	10 2284083	25 0 2934606	.0650523
36	9 7067531	9 9348730	9 7718801	10 2281199	24 0 2932469	.0651270
37	9 7069667	9 9347983	9 7721684	10 2278316	23 0 2930333	.0652017
38	9 7071801	9 9347235	9 7724566	10 2275434	22 0 2928199	.0652765
39	9 7073933	9 9346486	9 7727447	10 2272553	21 0 2926067	.0653514
40	9 7076064	9 9345738	9 7730327	10 2269673	20 0 2923936	.0654262
41	9 7078194	9 9344988	9 7733206	10 2266794	19 0 2921806	.0655012
42	9 7080323	9 9344238	9 7736084	10 2263916	18 0 2919677	.0655762
43	9 7082450	9 9343488	9 7738961	10 2261039	17 0 2917550	.0656512
44	9 7084575	9 9342737	9 7741838	10 2258162	16 0 2915425	.0657263
45	9 7086699	9 9341986	9 7744713	10 2255287	15 0 2913301	.0658014
46	9 7088822	9 9341234	9 7747588	10 2252412	14 0 2911178	.0658766
47	9 7090943	9 9340482	9 7750462	10 2249538	13 0 2909057	.0659518
48	9 7093063	9 9339729	9 7753334	10 2246666	12 0 2906937	.0660271
49	9 7095182	9 9338976	9 7756206	10 2243794	11 0 2904818	.0661024
50	9 7097299	9 9338222	9 7759077	10 2240943	10 0 2902701	.0661778
51	9 7099415	9 9337467	9 7761947	10 2238053	9 0 2900585	.0662533
52	9 7101529	9 9336713	9 7764816	10 2235184	8 0 2898471	.0663287
53	9 7103642	9 9335957	9 7767685	10 2232315	7 0 2896358	.0664043
54	9 7105753	9 9335206	9 7770552	10 2229448	6 0 2894247	.0664799
55	9 7107863	9 9334445	9 7773418	10 2226582	5 0 2892137	.0665555
56	9 7109972	9 9333688	9 7776284	10 2223716	4 0 2890028	.0666312
57	9 7112080	9 9332931	9 7779149	10 2220851	3 0 2887920	.0667069
58	9 7114186	9 9332173	9 7782012	10 2217988	2 0 2885814	.0667827
59	9 7116290	9 9331415	9 7784875	10 2215125	1 0 2883710	.0668585
60	9 7118393	9 9330656	9 7787737	10 2212263	0 0 2881607	.0669344

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 7118393	9 9330656	9 7787737	10 2212263	60	0 2881607	.0669344
1	9 7120495	9 9329897	9 7790599	10 2209401	59	0 2879505	.0670103
2	9 7122596	9 9329137	9 7793459	10 2206541	58	0 2877404	.0670863
3	9 7124695	9 9328376	9 7796318	10 2203682	57	0 2875305	.0671624
4	9 7126792	9 9327616	9 7799177	10 2200823	56	0 2873208	.0672384
5	9 7128889	9 9326854	9 7802034	10 2197966	55	0 2871111	.0673146
6	9 7130983	9 9326092	9 7804891	10 2195109	54	0 2869017	.0673908
7	9 7133077	9 9325330	9 7807747	10 2192253	53	0 2866923	.0674670
8	9 7135169	9 9324567	9 7810602	10 2189398	52	0 2864831	.0675433
9	9 7137260	9 9323804	9 7813456	10 2186544	51	0 2862740	.0676196
10	9 7139349	9 9323040	9 7816309	10 2183691	50	0 2860651	.0676960
11	9 7141437	9 9322276	9 7819162	10 2180838	49	0 2858563	.0677724
12	9 7142524	9 9321511	9 7822013	10 2177987	48	0 2856476	.0678489
13	9 7145609	9 9320746	9 7824864	10 2175136	47	0 2854391	.0679254
14	9 7147693	9 9319980	9 7827713	10 2172287	46	0 2852307	.0680020
15	9 7149776	9 9319213	9 7830562	10 2169438	45	0 2850224	.0680787
16	9 7151857	9 9318447	9 7833410	10 2166590	44	0 2848143	.0681553
17	9 7153937	9 9317679	9 7836258	10 2163742	43	0 2846063	.0682321
18	9 7156015	9 9316911	9 7839104	10 2160896	42	0 2843985	.0683089
19	9 7158092	9 9316143	9 7841949	10 2158051	41	0 2841908	.0683857
20	9 7160168	9 9315374	9 7844794	10 2155206	40	0 2839832	.0684626
21	9 7162243	9 9314605	9 7847638	10 2152362	39	0 2837757	.0685395
22	9 7164316	9 9313835	9 7850481	10 2149519	38	0 2835684	.0686165
23	9 7166387	9 9313065	9 7853323	10 2146677	37	0 2833613	.0686935
24	9 7168458	9 9312294	9 7856164	10 2143836	36	0 2831542	.0687706
25	9 7170526	9 9311522	9 7859004	10 2140996	35	0 2829474	.0688478
26	9 7172594	9 9310750	9 7861844	10 2138156	34	0 2827406	.0689250
27	9 7174660	9 9309978	9 7864682	10 2135318	33	0 2825340	.0690022
28	9 7176725	9 9309205	9 7867520	10 2132480	32	0 2823275	.0690795
29	9 7178789	9 9308432	9 7870357	10 2129643	31	0 2821211	.0691568
30	9 7180851	9 9307658	9 7873193	10 2126807	30	0 2819149	.0692342

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	9 7180851	9 9307558	9 7873193	10 2126807	30	0 2819149	.0692342
31	9 7182912	9 9306883	9 7876028	10 2123972	29	0 2817088	.0693117
32	9 7184971	9 9306109	9 7878863	10 2121137	28	0 2815029	.0693898
33	9 7187030	9 9305333	9 7881696	10 2118304	27	0 2812970	.0694667
34	9 7189086	9 9304557	9 7884529	10 2115471	26	0 2810914	.0695443.
35	9 7191142	9 9303781	9 7887361	10 2112639	25	0 2808858	.0696219
36	9 7193196	9 9303004	9 7890192	10 2109808	24	0 2806804	.0696996
37	9 7195249	9 9302226	9 7893023	10 2106977	23	0 2804751	.0697774
38	9 7197300	9 9301448	9 7895852	10 2104148	22	0 2802700	.0698552
39	9 7199350	9 9300670	9 7898681	10 2101319	21	0 2800650	.0699330
40	9 7201399	9 9299891	9 7901508	10 2098492	20	0 2798601	.0700109
41	9 7203447	9 9299112	9 7904335	10 2095665	19	0 2796553	.0700888
42	9 7205493	9 9298332	9 7907161	10 2092839	18	0 2794507	.0701668
43	9 7207538	9 9297551	9 7909987	10 2090013	17	0 2792462	.0702449
44	9 7209581	9 9296770	9 7912811	10 2087189	16	0 2790419	.0703230
45	9 7211623	9 9295989	9 7915635	10 2084365	15	0 2788377	.0704011
46	9 7213664	9 9295207	9 7918458	10 2081542	14	0 2786335	.0704793
47	9 7215704	9 9294424	9 7921280	10 2078720	13	0 2784296	.0705576
48	9 7217742	9 9293641	9 7924101	10 2075899	12	0 2782258	.0706359
49	9 7219779	9 9292857	9 7926921	10 2073079	11	0 2780221	.0707143
50	9 7221814	9 9292073	9 7929741	10 2070259	10	0 2778186	.0707927
51	9 7223848	9 9291289	9 7932560	10 2067440	9	0 2776152	.0708711
52	9 7225881	9 9290504	9 7935378	10 2054622	8	0 2774119	.0709496
53	9 7227913	9 9289718	9 7938195	10 2061805	7	0 2772087	.0710282
54	9 7229943	9 9288932	9 7941011	10 2058989	6	0 2770057	.0711068
55	9 7231972	9 9288145	9 7943827	10 2056173	5	0 2768028	.0711855
56	9 7234000	9 9287358	9 7946641	10 2053359	4	0 2766000	.0712642
57	9 7236026	9 9286571	9 7949455	10 2050545	3	0 2763974	.0713429
58	9 7238051	9 9285783	9 7952268	10 2047732	2	0 2761949	.0714217
59	9 7240075	9 9284994	9 7955081	10 2044919	1	0 2759925	.0715006
60	9 7242097	9 9284205	9 7957892	10 2042108	0	0 2757903	.0715795

SINE Complement.	Sine.	Tangent. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 7242097	9 9284205	9 7957892	10 2042108	60	0 2757903	•0715795
1	9 7244118	9 9283415	9 7960703	10 2039297	59	0 2755882	•0716585
2	9 7246138	9 9282625	9 7963513	10 2036487	58	0 2753862	•0717375
3	9 7248156	9 9281834	9 7966322	10 2033678	57	0 2751844	•0718166
4	9 7250174	9 9281043	9 7969130	10 2030870	56	0 2749826	•0718957
5	9 7252189	9 9280251	9 7971938	10 2028062	55	0 2747811	•0719749
6	9 7254204	9 9279459	9 7974745	10 2025255	54	0 2745796	•0720541
7	9 7256217	9 9278666	9 7977551	10 2022449	53	0 2743783	•0721334
8	9 7258229	9 9277873	9 7980356	10 2019644	52	0 2741771	•0722127
9	9 7260240	9 9277079	9 7983160	10 2016840	51	0 2739760	•0722921
10	9 7262249	9 9276285	9 7985964	10 2014036	50	0 2737751	•0723715
11	9 7264257	9 9275490	9 7988767	10 2011233	49	0 2735743	•0724510
12	9 7266264	9 9274695	9 7991569	10 2008431	48	0 2733736	•0725305
13	9 7268269	9 9273899	9 7994370	10 2005630	47	0 2731731	•0726101
14	9 7270273	9 9273103	9 7997170	10 2002830	46	0 2729727	•0726897
15	9 7272276	9 9272306	9 7999970	10 2000030	45	0 2727724	•0727694
16	9 7274278	9 9271509	9 8002769	10 1997231	44	0 2725722	•0728491
17	9 7276278	9 9270711	9 8005567	10 1994433	43	0 2723722	•0729289
18	9 7278277	9 9269913	9 8008365	10 1991635	42	0 2721723	•0730087
19	9 7280275	9 9269114	9 8011161	10 1988839	41	0 2719725	•0730886
20	9 7282271	9 9268314	9 8013957	10 1986043	40	0 2717729	•0731686
21	9 7284267	9 9267514	9 8016752	10 1983248	39	0 2715733	•0732486
22	9 7286260	9 9266714	9 8019546	10 1980454	38	0 2713740	•0733286
23	9 7288253	9 9265913	9 8022340	10 1977660	37	0 2711747	•0734087
24	9 7290244	9 9265112	9 8025133	10 1974867	36	0 2709756	•0734888
25	9 7292234	9 9264310	9 8027925	10 1972075	35	0 2707766	•0735690
26	9 7294223	9 9263507	9 8030716	10 1969284	34	0 2705777	•0736493
27	9 7296211	9 9262704	9 8033506	10 1966494	33	0 2703790	•0737296
28	9 7298197	9 9261901	9 8036296	10 1963704	32	0 2701803	0738099
29	9 7300182	9 9261096	9 8039085	10 1960915	31	0 2699818	•0738904
30	9 7302165	9 9260292	9 8041873	10 1958127	30	0 2697835	•0739708

SINE Comple-ment.	Sine	TANG. Comple-ment.	Tang.	M

M	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	9 7302165	9 9260292	9 8041873	10 1958127	30	0 2697835	·0739708
31	9 7304148	9 9259487	9 8044661	10 1955339	29	0 2695852	·0740513
32	9 7306129	9 9258681	9 8047447	10 1952553	28	0 2693871	·0741319
33	9 7308109	9 9257875	9 8050233	10 1949767	27	0 2691891	·0742125
34	9 7310087	9 9257069	9 8053019	10 1946981	26	0 2689913	·0742931
35	9 7312064	9 9256261	9 8055803	10 1944197	25	0 2687936	·0743739
36	9 7314040	9 9255454	9 8058587	10 1941413	24	0 2685960	·0744546
37	9 7316015	9 9254646	9 8061370	10 1938630	23	0 2683985	·0745354
38	9 7317989	9 9253837	9 8064152	10 1935848	22	0 2682011	·0746163
39	9 7319961	9 9253028	9 8066933	10 1933067	21	0 2680039	·0746972
40	9 7321932	9 9252218	9 8069714	10 1930286	20	0 2678068	·0747782
41	9 7323902	9 9251408	9 8072494	10 1927506	19	0 2676098	·0748592
42	9 7325870	9 9250597	9 8075273	10 1924727	18	0 2674130	·0749403
43	9 7327837	9 9249786	9 8078052	10 1921948	17	0 2672163	·0750214
44	9 7329803	9 9248974	9 8080829	10 1919171	16	0 2670197	·0751026
45	9 7331768	9 9248161	9 8083606	10 1916394	15	0 2668232	·0751839
46	9 7333731	9 9247349	9 8086383	10 1913617	14	0 2666269	·0752651
47	9 7335693	9 9246535	9 8089158	10 1910842	13	0 2664307	·0753465
48	9 7337654	9 9245721	9 8091933	10 1908067	12	0 2662346	·0754297
49	9 7339614	9 9244907	9 8094707	10 1905293	11	0 2660386	·0755093
50	9 7341572	9 9244092	9 8097480	10 1902520	10	0 2658428	·0755908
51	9 7343529	9 9243277	9 8100253	10 1899747	9	0 2656471	·0756723
52	9 7345485	9 9242461	9 8103025	10 1896975	8	0 2654515	·0757539
53	9 7347440	0 9241644	9 8105796	10 1894204	7	0 2652560	·0758356
54	9 7349393	9 9240827	9 8108566	10 1891434	6	0 2650607	·0759173
55	9 7351345	9 9240010	9 8111336	10 1888664	5	0 2648655	·0759990
56	9 7353296	9 9239191	9 8114105	10 1885895	4	0 2646704	·0760809
57	9 7355246	9 9238373	9 8116873	10 1883127	3	0 2644754	·0761627
58	9 7357195	9 9237554	9 8119641	10 1880359	2	0 2642805	·0762446
59	9 7359142	9 9236734	9 8122408	10 1877592	1	0 2640858	·0763266
60	9 7361088	9 9235914	9 8125174	10 1874826	0	0 2638912	·0764086

SINE Comple-ment.	Sine.	Tangent. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 7361088	9 9235914	9 8125174	10 1874826	60	0 2638912	.0764086
1	9 7363032	9 9235093	9 8127939	10 1872061	59	0 2636968	.0764907
2	9 7364976	9 9234272	9 8130704	10 1869296	58	0 2635024	.0765728
3	9 7366918	9 9233450	9 8133468	10 1866532	57	0 2633082	.0766550
4	9 7368859	9 9232628	9 8136231	10 1863769	56	0 2631141	.0767372
5	9 7370799	9 9231805	9 8138993	10 1861007	55	0 2629201	.0768195
6	9 7372737	9 9230982	9 8141755	10 1858245	54	0 2627263	.0769018
7	9 7374675	9 9230158	9 8144516	10 1855484	53	0 2625325	.0769842
8	9 7376611	9 9229334	9 8147277	10 1852723	52	0 2623389	.0770666
9	9 7378546	9 9228509	9 8150036	10 1849964	51	0 2621454	.0771491
10	9 7380479	9 9227684	9 8152795	10 1847205	50	0 2619521	.0772316
11	9 7382412	9 9226858	9 8155554	10 1844446	49	0 2617588	.0773142
12	9 7384343	9 9226032	9 8158311	10 1841689	48	0 2615657	.0773969
13	9 7386273	9 9225205	9 8161068	10 1838932	47	0 2613727	.0774795
14	9 7388201	9 9224377	9 8163824	10 1836176	46	0 2611799	.0775623
15	9 7390129	9 9223549	9 8166580	10 1833420	45	0 2609871	.0776451
16	9 7392055	9 9222721	9 8169335	10 1830665	44	0 2607945	.0777279
17	9 7393980	9 9221891	9 8172089	10 1827911	43	0 2606020	.0778109
18	9 7395904	9 9221062	9 8174842	10 1825158	42	0 2604096	.0778938
19	9 7397827	9 9220232	9 8177595	10 1822405	41	0 2602173	.0779768
20	9 7399748	9 9219401	9 8180347	10 1819653	40	0 2600252	.0780599
21	9 7401668	9 9218570	9 8183098	10 1816902	39	0 2598332	.0781430
22	9 7403587	9 9217738	9 8185849	10 1814151	38	0 2596413	.0782262
23	9 7405505	9 9216906	9 8188599	10 1811401	37	0 2594495	.0783094
24	9 7407421	9 9216073	9 8191348	10 1808652	36	0 2592579	.0783927
25	9 7409337	9 9215240	9 8194095	10 1805904	35	0 2590663	.0784760
26	9 7411251	9 9214406	9 8196844	10 1803156	34	0 2588749	.0785594
27	9 7413164	9 9213572	9 8199592	10 1800408	33	0 2586836	.0786428
28	9 7415075	9 9212737	9 8202338	10 1797662	32	0 2584925	.0787263
29	9 7416986	9 9211902	9 8205084	10 1794916	31	0 2583014	.0788068
30	9 7418895	9 9211065	9 8207829	10 1792171	30	0 2581105	.0788934

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Comp. Arith. of Sine Com.
30	9 7418895	9 9211066	9 8207829	10 1792171	30	0 2581105	.0788934
31	9 7420803	9 9210229	9 8210574	10 1789426	29	0 2579197	.0789771
32	9 7422710	9 9209393	9 8213317	10 1786683	28	0 2577299	.0790607
33	9 7424616	9 9208555	9 8216060	10 1783940	27	0 2575384	.0791445
34	9 7426520	9 9207717	9 8218803	10 1781197	26	0 2573480	.0792283
35	9 7428423	9 9206878	9 8221545	10 1778455	25	0 2571577	.0793122
36	9 7430325	9 9206039	9 8224286	10 1775714	24	0 2569675	.0793961
37	9 7432226	9 9205200	9 8227026	10 1772974	23	0 2567774	.0794800
38	9 7434126	9 9204360	9 8229766	10 1770234	22	0 2565874	.0795640
39	9 7436024	9 9203519	9 8232505	10 1767495	21	0 2563976	.0796481
40	9 7437921	9 9202678	9 8235244	10 1764756	20	0 2562079	.0797322
41	9 7439817	9 9201836	9 8237981	10 1762019	19	0 2560183	.0798164
42	9 7441712	9 9200994	9 8240719	10 1759281	18	0 2558288	.0799006
43	9 7443606	9 9200151	9 8243455	10 1756545	17	0 2556394	.0799849
44	9 7445498	9 9199308	9 8246191	10 1753809	16	0 2554502	.0800692
45	9 7447390	9 9198464	9 8248926	10 1751074	15	0 2552610	.0801536
46	9 7449280	9 9197619	9 8251660	10 1748340	14	0 2550720	.0802381
47	9 7451169	9 9196775	9 8254394	10 1745606	13	0 2548831	.0803225
48	9 7453056	9 9195929	9 8257127	10 1742873	12	0 2546944	.0804071
49	9 7454943	9 9195083	9 8259860	10 1740140	11	0 2545057	.0804917
50	9 7456828	9 9194237	9 8262592	10 1737408	10	0 2543172	.0805763
51	9 7458712	9 9193390	9 8265323	10 1734677	9	0 2541288	.0806610
52	9 7460595	9 9192542	9 8268053	10 1731947	8	0 2539405	.0807458
53	9 7462477	9 9191694	9 8270783	10 1729217	7	0 2537523	.0808306
54	9 7464358	9 9190845	9 8273513	10 1726487	6	0 2535642	.0809155
55	9 7466237	9 9189996	9 8276241	10 1723759	5	0 2533763	.0810004
56	9 7468115	9 9189146	9 8278969	10 1721031	4	0 2531885	.0810854
57	9 7469992	9 9188296	9 8281696	10 1718304	3	0 2530008	.0811704
58	9 7471868	9 9187445	9 8284423	10 1715577	2	0 2528132	.0812555
59	9 7473743	9 9186594	9 8287149	10 1712851	1	0 2526257	.0813406
60	9 7475617	9 9185742	9 8289874	10 1710126	0	0 2524383	.0814258

	SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 7475617	9 9185742	9 8280875	10 1710126	60	0 2524383	.0814258
1	9 7477489	9 9184890	9 8292599	10 1707401	59	0 2522511	.0815110
2	9 7479360	9 9184037	9 8295323	10 1704677	58	0 2520640	.0815963
3	9 7481230	9 9183183	9 8298047	10 1701953	57	0 2518770	.0816817
4	9 7483099	9 9182329	9 8300769	10 1699231	56	0 2516901	.0817671
5	9 7484967	9 9181475	9 8303492	10 1696508	55	0 2515033	.0818525
6	9 7486833	9 9180620	9 8306213	10 1693787	54	0 2513167	.0819380
7	9 7488698	9 9179764	9 8308934	10 1691065	53	0 2511302	.0820236
8	9 7490562	9 9178908	9 8311654	10 1688346	52	0 2509438	.0821092
9	9 7492425	9 9178051	9 8314374	10 1685626	51	0 2507575	.0821949
10	9 7494287	9 9177194	9 8317093	10 1682907	50	0 2505713	.0822806
11	9 7496148	9 9176336	9 8319811	10 1680189	49	0 2503852	.0823664
12	9 7498007	9 9175478	9 8322529	10 1677471	48	0 2501993	.0824522
13	9 7499866	9 9174619	9 8325246	10 1674754	47	0 2500134	.0825381
14	9 7501723	9 9173760	9 8327963	10 1672037	46	0 2498277	.0826240
15	9 7503579	9 9172900	9 8330679	10 1669321	45	0 2496421	.0827100
16	9 7505434	9 9172040	9 8333394	10 1666606	44	0 2494566	.0827960
17	9 7507287	9 9171179	9 8336109	10 1663991	43	0 2492713	.0828821
18	9 7509140	9 9170317	9 8338823	10 1661177	42	0 2490860	.0829683
19	9 7510991	9 9169455	9 8341536	10 1658464	41	0 2489009	.0830545
20	9 7512842	9 9168593	9 8344249	10 1655751	40	0 2487158	.0831407
21	9 7514691	9 9167730	9 8346961	10 1653039	39	0 2485309	.0832270
22	9 7516538	9 9166866	9 8349673	10 1650327	38	0 2483462	.0833134
23	9 7518385	9 9166002	9 8352384	10 1647616	37	0 2481615	.0833998
24	9 7520231	9 9165137	9 8355094	10 1644906	36	0 2479769	.0834863
25	9 7522075	9 9164272	9 8357804	10 1642196	35	0 2477925	.0835728
26	9 7523919	9 9163406	9 8360513	10 1639487	34	0 2476081	.0836594
27	9 7525761	9 9162539	9 8363221	10 1636779	33	0 2474239	.0837461
28	9 7527602	9 9161673	9 8365929	10 1634071	32	0 2472398	.0838327
29	9 7529442	9 9160805	9 8368636	10 1631364	31	0 2470558	.0839195
30	9 7531280	9 9159937	9 8371343	10 1628657	30	0 2468720	.0840063

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com.
30	9 7531280	9 9159937	9 8371343	10 1628657	30	0 2468720	.0840063
31	9 7533118	9 9159069	9 8374049	10 1625951	29	0 2466882	.0840931
32	9 7534954	9 9158200	9 8376755	10 1623245	28	0 2465046	.0841800
33	9 7536790	9 9157330	9 8379460	10 1620540	27	0 2463210	.0842670
34	9 7538624	9 9156460	9 8382164	10 1617836	26	0 2461376	.0843540
35	9 7540457	9 9155589	9 8384867	10 1615133	25	0 2459543	.0844411
36	9 7542288	9 9154718	9 8387571	10 1612429	24	0 2457712	.0845282
37	9 7544119	9 9153846	9 8390273	10 1609727	23	0 2455881	.0846154
38	9 7545949	9 9152974	9 8392975	10 1607025	22	0 2454051	.0847026
39	9 7547777	9 9152101	9 8395676	10 1604324	21	0 2452223	.0847899
40	9 7549604	9 9151228	9 8398377	10 1601623	20	0 2450396	.0848772
41	9 7551431	9 9150354	9 8401077	10 1598923	19	0 2448569	.0849646
42	9 7553056	9 9149479	9 8403776	10 1596224	18	0 2446744	.0850521
43	9 7555080	9 9148604	9 8406475	10 1593525	17	0 2444920	.0851396
44	9 7556902	9 9147729	9 8409174	10 1590826	16	0 2443098	.0852271
45	9 7558724	9 9146852	9 8411871	10 1588129	15	0 2441276	.0853148
46	9 7560544	9 9145976	9 8414569	10 1585431	14	0 2439456	.0854024
47	9 7562364	9 9145099	9 8417265	10 1582735	13	0 2437636	.0854901
48	9 7564182	9 9144221	9 8419961	10 1580039	12	0 2435818	.0855779
49	9 7565999	9 9143342	9 8422657	10 1577343	11	0 2434001	.0856658
50	9 7567815	9 9142464	9 8425351	10 1574649	10	0 2432185	.0857536
51	9 7569630	9 9141584	9 8428046	10 1571954	9	0 2430370	.0858416
52	9 7571444	9 9140704	9 8430739	10 1569261	8	0 2428556	.0859296
53	9 7573256	9 9139824	9 8433432	10 1566568	7	0 2426744	.0860176
54	9 7575068	9 9138943	9 8436125	10 1563875	6	0 2424932	.0861057
55	9 7576878	9 9138061	9 8438817	10 1561183	5	0 2423122	.0861939
56	9 7578687	9 9137179	9 8441508	10 1558492	4	0 2421313	.0862821
57	9 7580495	9 9136296	9 8444199	10 1555801	3	0 2419505	.0863704
58	9 7582302	9 9135413	9 8446889	10 1553111	2	0 2417698	.0864587
59	9 7584108	9 9134530	9 8449579	10 1550421	1	0 2415892	.0865471
60	9 7585913	9 9133645	9 8452268	10 1547732	0	0 2414087	.0866355

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 7585913	9 9133645	9 8452268	10 1547732	60	0 2414087	.0866355
1	9 7587717	9 9132760	9 8454956	10 1545044	59	0 2412283	.0867240
2	9 7589519	9 9131875	9 8457644	10 1542356	58	0 2410481	.0868125
3	9 7591321	9 9130989	9 8460332	10 1539668	57	0 2408679	.0869011
4	9 7593121	9 9130102	9 8463018	10 1536982	56	0 2406879	.0869898
5	9 7594920	9 9129215	9 8465705	10 1534295	55	0 2405080	.0870785
6	9 7596718	9 9128328	9 8468390	10 1531610	54	0 2403282	.0871672
7	9 7598515	9 9127440	9 8471075	10 1528925	53	0 2401485	.0872560
8	9 7600311	9 9126551	9 8473760	10 1526240	52	0 2399689	.0873449
9	9 7602106	9 9125662	9 8476444	10 1523556	51	0 2397894	.0874338
10	9 7603899	9 9124772	9 8479127	10 1520873	50	0 2396101	.0875228
11	9 7605692	9 9123882	9 8481810	10 1518190	49	0 2394308	.0876118
12	9 7607483	9 9122991	9 8484492	10 1515508	48	0 2392517	.0877009
13	9 7609274	9 9122099	9 8487174	10 1512826	47	0 2390726	.0877901
14	9 7611063	9 9121207	9 8489855	10 1510145	46	0 2388937	.0878793
15	9 7612851	9 9120315	9 8492536	10 1507464	45	0 2387149	.0879685
16	9 7614638	9 9119422	9 8495216	10 1504784	44	0 2385362	.0880578
17	9 7616424	9 9118528	9 8497896	10 1502104	43	0 2383576	.0881472
18	9 7618208	9 9117634	9 8500575	10 1499425	42	0 2381792	.0882366
19	9 7619992	9 9116739	9 8503253	10 1496747	41	0 2380008	.0883261
20	9 7621775	9 9115844	9 8505931	10 1494069	40	0 2378225	.0884156
21	9 7623556	9 9114948	9 8508606	10 1491392	39	0 2376444	.0885052
22	9 7625337	9 9114051	9 8511285	10 1488715	38	0 2374663	.0885949
23	9 7627116	9 9113154	9 8513961	10 1486039	37	0 2372884	.0886845
24	9 7628894	9 9112257	9 8516637	10 1483363	36	0 2371106	.0887743
25	9 7630671	9 9111359	9 8519312	10 1480688	35	0 2369329	.0888641
26	9 7632447	9 9110460	9 8521987	10 1478013	34	0 2367553	.0889540
27	9 7634222	9 9109561	9 8524661	10 1475339	33	0 2365778	.0890439
28	9 7635996	9 9108661	9 8527335	10 1472665	32	0 2364004	.0891339
29	9 7637769	9 9107761	9 8530008	10 1469992	31	0 2362231	.0892239
30	9 7639540	9 9106860	9 8532680	10 1467320	30	0 2360460	.0893140

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	9 7639540	9 9106860	9 8532680	10 1467320	30	0 2360460	.0893140
31	9 7641311	9 9105959	9 8535352	10 1464648	29	0 2358689	.0894041
32	9 7643080	9 9105057	9 8538023	10 1461977	28	0 2356920	.0894943
33	9 7644849	9 9104155	9 8540694	10 1459306	27	0 2355151	.0895845
34	9 7646616	9 9103251	9 8543365	10 1456635	26	0 2353384	.0896749
35	9 7658382	9 9102348	9 8546034	10 1453966	25	0 2351618	.0897652
36	9 7650147	9 9101444	9 8548704	10 1451296	24	0 2349853	.0898556
37	9 7651911	9 9100539	9 8551372	10 1448628	23	0 2348089	.0899461
38	9 7653674	9 9099634	9 8554041	10 1445959	22	0 2346326	.0900366
39	9 7655436	9 9098728	9 8556708	10 1443292	21	0 2344564	.0901272
40	9 7657197	9 9097821	9 8559376	10 1440624	20	0 2342803	.0902179
41	9 7658957	9 9096915	9 8562042	10 1437958	19	0 2341043	.0903085
42	9 7660715	9 9096007	9 8564708	10 1435292	18	0 2339285	.0903993
43	9 7662473	9 9095099	9 8567374	10 1432626	17	0 2337527	.0904901
44	9 7664229	9 9094190	9 8570039	10 1429961	16	0 2335771	.0905810
45	9 7665985	9 9093281	9 8572704	10 1427296	15	0 2334015	.0906719
46	9 7667739	9 9092371	9 8575368	10 1424632	14	0 2332261	.0907629
47	9 7669492	9 9091461	9 8578031	10 1421969	13	0 2330508	.0908539
48	9 7671244	9 9090550	9 8580694	10 1419306	12	0 2328756	.0909450
49	9 7672996	9 9089639	9 8583357	10 1416643	11	0 2327004	.0910361
50	9 7674746	9 9088727	9 8586019	10 1413981	10	0 2325254	.0911273
51	9 7676494	9 9087814	9 8588680	10 1411320	9	0 2323506	.0912186
52	9 7678242	9 9086901	9 8591341	10 1408659	8	0 2321758	.0913099
53	9 7679989	9 9085988	9 8594002	10 1405998	7	0 2320011	.0914012
54	9 7681735	9 9085073	9 8596661	10 1403339	6	0 2318265	.0914927
55	9 7683480	9 9084159	9 8599321	10 1400679	5	0 2316520	.0915841
56	9 7685223	9 9083243	9 8601980	10 1398020	4	0 2314777	.0916757
57	9 7686966	9 9082327	9 8604638	10 1395362	3	0 2313034	.0917673
58	9 7688707	9 9081411	9 8607296	10 1392704	2	0 2311293	.0918589
59	9 7690448	9 9080494	9 8609954	10 1390046	1	0 2309552	.0919506
60	9 7692187	9 9079576	9 8612610	10 1387390	0	0 2307813	.0920424

SINE Comple-ment.	Sine.	Tangent. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 7692185	9 9079576	9 8612610	10 1387390	60	0 2307813	.0920424
1	9 7693925	9 9078658	9 8615267	10 1384733	59	0 2306075	.0921342
2	9 7695662	9 9077740	9 8617923	10 1382077	58	0 2304338	.0923260
3	9 7697398	9 9076820	9 8620578	10 1379422	57	0 2302602	.0923180
4	9 7699134	9 9075901	9 8623233	10 1376767	56	0 2300865	.0924099
5	9 7700868	9 9074980	9 8625887	10 1374113	55	0 2299132	.0925020
6	9 7702601	9 9074059	9 8628541	10 1371459	54	0 2297399	.0925941
7	9 7704332	9 9073138	9 8631195	10 1368805	53	0 2295668	.0926862
8	9 7706063	9 9072216	9 8633848	10 1366152	52	0 2293937	.0927784
9	9 7707793	9 9071293	9 8636500	10 1363500	51	0 2292207	.0928707
10	9 7709522	9 9070370	9 8639152	10 1360848	50	0 2290478	.0929630
11	9 7711249	9 9069446	9 8641803	10 1358197	49	0 2288751	.0930554
12	9 7712976	9 9068522	9 8644454	10 1355546	48	0 2287024	.0931478
13	9 7714702	9 9067597	9 8647105	10 1352895	47	0 2285298	.0932403
14	9 7716426	9 9066671	9 8649755	10 1350245	46	0 2283574	.0933329
15	9 7718150	9 9065745	9 8652404	10 1347596	45	0 2281850	.0934255
16	9 7719872	9 9064819	9 8655053	10 1344947	44	0 2280128	.0935181
17	9 7721593	9 9063892	9 8657702	10 1342298	43	0 2278407	.0936108
18	9 7723314	9 9062964	9 8660350	10 1339650	42	0 2276686	.0937036
19	9 7725033	9 9062036	9 8662997	10 1337003	41	0 2274967	.0937964
20	9 7726751	9 9061107	9 8665644	10 1334356	40	0 2273249	.0938893
21	9 7728468	9 9060177	9 8668291	10 1331709	39	0 2271532	.0939823
22	9 7730185	9 9059247	9 8670937	10 1329063	38	0 2269815	.0940753
23	9 7731900	9 9058317	9 8673583	10 1326417	37	0 2268100	.0941683
24	9 7733614	9 9057386	9 8676228	10 1323772	36	0 2266386	.0942614
25	9 7735327	9 9056454	9 8678873	10 1321127	35	0 2264673	.0943546
26	9 7737039	9 9055522	9 8681517	10 1318483	34	0 2262961	.0944478
27	9 7738749	9 9054589	9 8684160	10 1315840	33	0 2261251	.0945411
28	9 7740459	9 9053656	9 8686804	10 1313196	32	0 2259541	.0946344
29	9 7742168	9 9042722	9 8689446	10 1310554	31	0 2257832	.0947278
30	9 7743876	9 9051787	9 8692089	10 1307911	30	0 2256124	.0948213

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	9 7743876	9 9051787	9 8692089	10 1307911	30	0 2256124	·0948213
31	9 7745583	9 9050852	9 8694731	10 1305269	29	0 2254417	·0949148
32	9 7747288	9 9049916	9 8697372	10 1302628	28	0 2252712	·0950084
33	9 7748993	9 9048980	9 8700013	10 1299987	27	0 2251097	·0951020
34	9 7750697	9 9048043	9 8702653	10 1297347	26	0 2249303	·0951957
35	9 7752399	9 9047106	9 8705293	10 1294707	25	0 2247601	·0952894
36	9 7754101	9 9046168	9 8707933	10 1292067	24	0 2245899	·0953832
37	9 7755801	9 9045230	9 8710572	10 1289428	23	0 2244199	·0954770
38	9 7753501	9 9044291	9 8713210	10 1286790	22	0 2242499	·0955709
39	9 7759199	9 9043351	9 8715848	10 1284152	21	0 2240801	·0956649
40	9 7760897	9 9042411	9 8718486	10 1281514	20	0 2239103	·0957589
41	9 7762593	9 9041470	9 8721123	10 1278877	19	0 2237407	·0958530
42	9 7764289	9 9040529	9 8723759	10 1276240	18	0 2235711	·0959471
43	9 7765983	9 9039587	9 8726396	10 1273604	17	0 2234017	·0960413
44	9 7767676	9 9038644	9 8729032	10 1270968	16	0 2232324	·0961356
45	9 7769369	9 9037701	9 8731668	10 1268332	15	0 2230631	·0962299
46	9 7771060	9 9036757	9 8734302	10 1265698	14	0 2228940	·0963243
47	9 7772750	9 9035813	9 8736937	10 1163063	13	0 2227250	·0964187
48	9 7774439	9 9034868	9 8739571	10 1260429	12	0 2225561	·0965132
49	9 7776128	9 9033923	9 8742204	10 1257796	11	0 2223872	·0966077
50	9 7777815	9 9032977	9 8744838	10 1255162	10	0 2222185	·0967023
51	9 7779501	9 9032031	9 8747470	10 1252530	9	0 2220499	·0967969
52	9 7781186	9 9031084	9 8750102	10 1249898	8	0 2218814	·0968916
53	9 7782870	0 9030136	9 8752734	10 1247266	7	0 2217130	·0969864
54	9 7784553	9 9029188	9 8755365	10 1144635	6	0 2215447	·0970812
55	9 7786235	9 9028239	9 8757996	10 1242004	5	0 2213765	·0971761
56	9 7787916	9 9027289	9 8760627	10 1239373	4	0 2212084	·0972711
57	9 7789596	9 9026339	9 8763257	10 1236743	3	0 2210404	·0973661
58	9 7791275	9 9025389	9 8765886	10 1234114	2	0 2208725	·0974611
59	9 7792953	9 9024438	9 8768515	10 1231485	1	0 2207047	·0975562
60	9 7794630	9 9023486	6 8771144	10 1228856	0	0 2205370	·0976514

SINE Comple-ment.	Sine.	Tangent. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 7794630	9 9023486	9 8771144	10 1228856	60	0 2205370	.0976514
1	9 7796306	9 9022534	9 8773772	10 1226228	59	0 2203694	.0977466
2	9 7797981	9 9021581	9 8776400	10 1223600	58	0 2202019	.0978419
3	9 7799655	9 9020628	9 8779027	10 1220973	57	0 2200345	.0979372
4	9 7801328	9 9019674	9 8781654	10 1218346	56	0 2198672	.0980326
5	9 7803000	9 9018719	9 8784281	10 1215719	55	0 2197000	.0981281
6	9 7804671	9 9017764	9 8786907	10 1213093	54	0 2195329	.0982236
7	9 7806341	9 9016808	9 8789533	10 1210467	53	0 2193659	.0983192
8	9 7808010	9 9015852	9 8792158	10 1207842	52	0 2191990	.0984148
9	9 7809677	9 9014895	9 8794782	10 1205218	51	0 2190323	.0985105
10	9 7811344	9 9013936	9 8797407	10 1202593	50	0 2188656	.0986062
11	9 7813010	9 9012980	9 8800031	10 1199969	49	0 2186990	.0987020
12	9 7814675	9 9012021	9 8802654	10 1197346	48	0 2185325	.0987979
13	9 7816339	9 9011062	9 8805277	10 1194723	47	0 2183661	.0988938
14	9 7818002	9 9010102	9 8807900	10 1192100	46	0 2181998	.0989898
15	9 7819664	9 9009142	9 8810522	10 1189478	45	0 2180336	.0990858
16	9 7821324	9 9008181	9 8813144	10 1186856	44	0 2178675	.0991819
17	9 7822984	9 9007219	9 8815765	10 1184235	43	0 2177016	.0992781
18	9 7824643	9 9006257	9 8818386	10 1181614	42	0 2175357	.0993743
19	9 7826301	9 9005294	9 8821007	10 1178993	41	0 2173699	.0994706
20	9 7827958	9 9004331	9 8823627	10 1176373	40	0 2172042	.0995669
21	9 7829614	9 9003367	9 8826246	10 1173754	39	0 2170386	.0996633
22	9 7831268	9 9002403	9 8828866	10 1171134	38	0 2168732	.0997597
23	9 7832922	9 9001438	9 8831484	10 1168516	37	0 2167078	.0998562
24	9 7834575	9 9000472	9 8834103	10 1165897	36	0 2165425	.0999528
25	9 7836227	9 8999506	9 8836721	10 1163279	35	0 2163773	.1000494
26	9 7837878	9 8998539	9 8839338	10 1160662	34	0 2162122	.1001461
27	9 7839528	9 8997572	9 8841956	10 1158044	33	0 2160472	.1002428
28	9 7841177	9 8996604	9 8844572	10 1155428	32	0 2158823	.1003396
29	9 7842824	9 8995636	9 8847189	10 1152811	31	0 2157176	.1004364
30	9 7844471	9 8994667	9 8849805	10 1150195	30	0 2155529	.1005333

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com.
30	9 7844471	9 8994667	9 8849805	10 1150195	30	0 2155529	.1005333
31	9 7846117	9 8993697	9 8852420	10 1147580	29	0 2153883	.1006303
32	9 7847762	9 8992727	9 8855035	10 1144965	28	0 2152238	.1007273
33	9 7849406	9 8991756	9 8857650	10 1142350	27	0 2150594	.1008244
34	9 7851049	9 8990784	9 8860264	10 1139736	26	0 2148951	.1009216
35	9 7852691	9 8989812	9 8862878	10 1137122	25	0 2147309	.1010188
36	9 7854332	9 8988840	9 8865492	10 1134508	24	0 2145668	.1011160
37	9 7855972	9 8987867	9 8868105	10 1131895	23	0 2144028	.1012133
38	9 7857611	9 8986893	9 8870718	10 1129282	22	0 2142389	.1013107
39	9 7859249	9 8985919	9 8873330	10 1126670	21	0 2140751	.1014081
40	9 7860886	9 8984944	9 8875942	10 1124058	20	0 2139111	.1015056
41	9 7862522	9 8983968	9 8878554	10 1121446	19	0 2137478	.1016032
42	9 7864157	9 8982992	9 8881165	10 1118835	18	0 2135843	.1017008
43	9 7865791	9 8982015	9 8883775	10 1116225	17	0 2134209	.1017985
44	9 7867424	9 8981038	9 8886386	10 1113614	16	0 2132576	.1018962
45	9 7869056	9 8980060	9 8888996	10 1111004	15	0 2130944	.1019940
46	9 7870687	9 8979082	9 8891605	10 1108395	14	0 2129313	.1020918
47	9 7872317	9 8978103	9 8894214	10 1105786	13	0 2127683	.1021897
48	9 7873946	9 8977123	9 8896823	10 1103177	12	0 2126054	.1022877
49	9 7875574	9 8976143	9 8899432	10 1100568	11	0 2124426	.1023857
50	9 7877202	9 8975162	9 8902040	10 1097960	10	0 2122798	.1024838
51	9 7878828	9 8974181	9 8904647	10 1095353	9	0 2121172	.1025819
52	9 7880453	9 8973199	9 8907254	10 1092746	8	0 2119547	.1026801
53	9 7882077	9 8972216	9 8909861	10 1090139	7	0 2117923	.1027784
54	9 7883701	9 8971233	9 8912468	10 1087532	6	0 2116299	.1028767
55	9 7885323	9 8970249	9 8915074	10 1084926	5	0 2114677	.1029751
56	9 7886944	9 8969265	9 8917679	10 1082321	4	0 2113056	.1030735
57	9 7888565	9 8968280	9 8920285	10 1079715	3	0 2111435	.1031720
58	9 7890184	9 8967294	9 8922890	10 1077110	2	0 2109816	.1032706
59	9 7891802	9 8966308	9 8925494	10 1074506	1	0 2108198	.1033692
60	9 7893420	9 8965321	9 8928098	10 1071902	0	0 2106580	.1034679

	SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 7893420	9 8965321	9 8928098	10 1071902	60	0 2106580	•1034679
1	9 7895036	9 8964334	9 8930702	10 1069298	59	0 2104064	•1035666
2	9 7896652	9 8963346	9 8933306	10 1066694	58	0 2103348	•1036654
3	9 7898266	9 8962358	9 8935909	10 1064091	57	0 2101734	•1037642
4	9 7899880	9 8961369	9 8938511	10 1061489	56	0 2100120	•1038631
5	9 7901493	9 8960379	9 8941114	10 1058886	55	0 2098507	•1039621
6	9 7903104	9 8959389	9 8943715	10 1056285	54	0 2096896	•1040611
7	9 7904715	9 8958398	9 8946317	10 1053683	53	0 2095285	•1041602
8	9 7906325	9 8957406	9 8948918	10 1051082	52	0 2093675	•1042594
9	9 7907933	9 8956414	9 8951519	10 1048481	51	0 2092067	•1043586
10	9 7909541	9 8955422	9 8954119	10 1045881	50	0 2090459	•1044578
11	9 7911148	9 8954429	9 8956719	10 1043281	49	0 2088852	•1045572
12	9 7912754	9 8953435	9 8959319	10 1040681	48	0 2087246	•1046565
13	9 7914359	9 8952440	9 8961918	10 1038082	47	0 2085641	•1047560
14	9 7915963	9 8951445	9 8964517	10 1035483	46	0 2084037	•1048555
15	9 7917566	9 8950450	9 8967116	10 1032884	45	0 2082434	•1149550
16	9 7919168	9 8949453	9 8969714	10 1030286	44	0 2080832	•1050547
17	9 7920769	9 8948457	9 8972312	10 1027688	43	0 2079231	•1051543
18	9 7922369	9 8947459	9 8974910	10 1025090	42	0 2077631	•1052541
19	9 7923968	9 8946461	9 8977507	10 1022493	41	0 2076032	•1053539
20	9 7925566	9 8945463	9 8980104	10 1019896	40	0 2074434	•1054537
21	9 7927163	9 8944463	9 8982700	10 1017300	39	0 2072837	•1055537
22	9 7928760	9 8943464	9 8985296	10 1014704	38	0 2071240	•1056536
23	9 7930355	9 8942463	9 8987892	10 1012108	37	0 2069645	•1057537
24	9 7931949	9 8941462	9 8990487	10 1009513	36	0 2068051	•1058538
25	9 7933543	9 8940461	9 8993082	10 1006918	35	0 2066457	•1059539
26	9 7935135	9 8939458	9 8995677	10 1004323	34	0 2064865	•1060542
27	9 7936727	9 8938456	9 8998271	10 1001729	33	0 2063279	•1061544
28	9 7938317	9 8937452	9 9000865	10 0999135	32	0 2061683	•1062548
29	9 7939907	9 8936448	9 9003459	10 0996541	31	0 2060093	•1063552
30	9 7941496	9 8935444	9 9006052	10 0993948	30	0 2058504	•1064556

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com.
30	9 7941496	9 8935444	9 9006052	10 0993948	30	0 2058504	.1064556
31	9 7943083	9 8931439	9 9008645	10 0991355	29	0 2056917	.1065561
32	9 7944670	9 8933433	9 9011237	10 0988763	28	0 2055330	.1066567
33	9 7946256	9 8932426	9 9013830	10 0986170	27	0 2053744	.1067574
34	9 7947841	9 8931419	9 9016422	10 0983578	26	0 2052159	.1068581
35	9 7949425	9 8930412	9 9019013	10 0980987	25	0 2050575	.1069588
36	9 7951008	9 8929404	9 9021604	10 0978396	24	0 2048992	.1070596
37	9 7952590	9 8928305	9 9024195	10 0975805	23	0 2047410	.1071605
38	9 7954171	9 8927385	9 9026786	10 0973214	22	0 2045829	.1072615
39	9 7955751	9 8926375	9 9029376	10 0970624	21	0 2044249	.1073625
40	9 7957330	9 8925365	9 9031966	10 0968034	20	0 2042670	.1074635
41	9 7958909	9 8924354	9 9034555	10 0965445	19	0 2041091	.1075646
42	9 7960486	9 8923342	9 9037144	10 0962856	18	0 2039514	.1076658
43	9 7962062	9 8922329	9 9039733	10 0960262	17	0 2037938	.1077671
44	9 7963638	9 8921316	9 9042321	10 0957679	16	0 2036362	.1078684
45	9 7965212	9 8920303	9 9044910	10 0955090	15	0 2034788	.1079697
46	9 7966786	9 8919289	9 9047497	10 0952503	14	0 2033214	.1080711
47	9 7968359	9 8918274	9 9050085	10 0949915	13	0 2031641	.1081726
48	9 7969930	9 8917258	9 9052672	10 0947328	12	0 2030070	.1082742
49	9 7971501	9 8916242	9 9055259	10 0944741	11	0 2028499	.1083758
50	9 7973071	9 8915226	9 9057885	10 0942155	10	0 2026929	.1084774
51	9 7974640	9 8914208	9 9060431	10 0939569	9	0 2025360	.1085792
52	9 7976208	9 8913191	9 9063017	10 0936983	8	0 2023792	.1086809
53	9 7977775	9 8912172	9 9065603	10 0934397	7	0 2022225	.1087828
54	9 7979341	9 8911153	9 9068188	10 0931812	6	0 2020659	.1088847
55	9 7980906	9 8910133	9 9070773	10 0929227	5	0 2019094	.1089867
56	9 7982470	9 8909113	9 9073357	10 0926643	4	0 2017530	.1090887
57	9 7984034	9 8908092	9 9075941	10 0924059	3	0 2015966	.1091908
58	9 7985596	9 8907071	9 9078525	10 0921475	2	0 2014401	.1092929
59	9 7987158	9 8906049	9 9081109	10 0918891	1	0 2012842	.1093951
60	9 7988718	9 8905026	9 9083692	10 0916308	0	0 2011282	.1094974

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 7988718	9 8905026	9 9083692	10 0916308	60	0 2011282	•1094974
1	9 7990278	9 8904003	9 9086275	10 0913725	59	0 2009722	•1095597
2	9 7991836	9 8902979	9 9088858	10 0911142	58	0 2008164	•1097021
3	9 7993394	9 8901954	9 9091440	10 0908569	57	0 2006606	•1098046
4	9 7994951	9 8900929	9 9094022	10 0905978	56	0 2005049	•1099071
5	9 7996507	9 8899903	9 9096603	10 0903397	55	0 2003493	•1100097
6	9 7998062	9 8898877	9 9099185	10 0800815	54	0 2001938	•1101123
7	9 7999616	9 8897850	9 9101766	10 0898234	53	0 2000384	•1102150
8	9 8001169	9 8896822	9 9104347	10 0895653	52	0 1998831	•1103178
9	9 8002721	9 8895794	9 9106927	10 0893073	51	0 1997279	•1104206
10	9 8004272	9 8894765	9 9109507	10 0890493	50	0 1995728	•1105235
11	9 8005823	9 8893736	9 9112087	10 0887913	49	0 1994177	•1106264
12	9 8007372	9 8892706	9 9114666	10 0885334	48	0 1992628	•1107294
13	9 8008921	9 8891675	9 9117245	10 0882755	47	0 1991079	•1108325
14	9 8010468	9 8890644	9 9119824	10 0880176	46	0 1989532	•1109356
15	9 8012015	9 8889612	9 9122403	10 0877567	45	0 1987985	•1110388
16	9 8013561	9 8888580	9 9124981	10 0875019	44	0 1986439	•1111420
17	9 8015106	9 8887547	9 9127559	10 0872411	43	0 1984894	•1112453
18	9 8016649	9 8886513	9 9130137	10 0869863	42	0 1983351	•1113487
19	9 8018192	9 8885479	9 9132714	10 0867286	41	0 1981808	•1114521
20	9 8019735	9 8884444	9 9135291	10 0864709	40	0 1980265	•1115556
21	9 8021276	9 8883408	9 9137808	10 0862132	39	0 1978724	•1116592
22	9 8022816	9 8882372	9 9140444	10 0859556	38	0 1977184	•1117628
23	9 8024355	9 8881335	9 9143020	10 0856980	37	0 1975645	•1118665
24	9 8025894	9 8880298	9 9145596	10 0854404	36	0 1974106	•1119702
25	9 8027431	9 8879260	9 9148171	10 0851829	35	0 1972569	•1120740
26	9 8028968	9 8878221	9 9150747	10 0849253	34	0 1971032	•1121779
27	9 8030504	9 8877182	9 9153322	10 0846678	33	0 1969496	•1122818
28	9 8032038	9 8876142	9 9155896	10 0844104	32	0 1967969	•1123858
29	9 8033572	9 8875102	9 9158471	10 0841529	31	0 1966428	•1124898
30	9 8035105	9 8874061	9 9161045	10 0838955	30	0 1964895	•1125939

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	9 8035105	9 8874061	9 9161045	10 0838955	30	0 1964895	•1125939
31	9 8036637	9 8873019	9 9163618	10 0836382	29	0 1963363	•1126981
32	9 8038168	9 8871977	9 9166192	10 0833808	28	0 1961832	•1128023
33	9 8039699	9 8870934	9 9168765	10 0831235	27	0 1960301	•1129066
34	9 8041228	9 8869890	9 9171338	10 0828662	26	0 1958772	•1130110
35	9 8042757	9 8868846	9 9173911	10 0826089	25	0 1957243	•1131154
36	9 8044284	9 8867801	9 9176483	10 0823517	24	0 1955716	•1132199
37	9 8045811	9 8866756	9 9179055	10 0820945	23	0 1954189	•1133244
38	9 8047336	9 8865710	9 9181627	10 0818373	22	0 1952664	•1134290
39	9 8048861	9 8864663	9 9184198	10 0815802	21	0 1951139	•1135337
40	9 8050385	9 8863616	9 9186769	10 0813231	20	0 1949615	•1136384
41	9 8051908	9 8862568	9 9189340	10 0810660	19	0 1948092	•1137432
42	9 8053430	9 8861519	9 9191911	10 0808089	18	0 1946570	•1138481
43	9 8054951	9 8860470	9 9194481	10 0805519	17	0 1945049	•1139530
44	9 8056472	9 8859420	9 9197051	10 0802949	16	0 1943528	•1140580
45	9 8057991	9 8858370	9 9199621	10 0800379	15	0 1942009	•1141630
46	9 8059510	6 8857319	9 9202191	10 0797809	14	0 1940490	•1142681
47	9 8061027	9 8856267	9 9204760	10 0795240	13	0 1938973	•1143733
48	9 8062544	9 8855215	9 9207329	10 0792671	12	0 1937456	•1144785
49	9 8064060	9 8854162	9 9209898	10 0790102	11	0 1935940	•1145838
50	9 8065575	9 8853109	9 9212466	10 0787534	10	0 1934425	•1156891
51	9 8067089	9 8852055	9 9215034	10 0784965	9	0 1932911	•1147945
52	9 8068602	9 8851000	9 9217602	10 0782398	8	0 1931398	•1149000
53	9 8070114	0 8849945	9 9220170	10 0779830	7	0 1929886	•1150055
54	9 8071626	9 8848889	9 9222737	10 0777263	6	0 1928374	•1151111
55	9 8073136	9 8847832	9 9225304	10 0774696	5	0 1926864	•1152168
56	9 8074646	9 8846775	9 9227871	10 0772129	4	0 1925354	•1153225
57	9 8076154	9 8845717	9 9230437	10 0769563	3	0 1923846	•1154283
58	9 8077662	9 8844659	9 9233004	10 0766996	2	0 1922338	•1155341
59	9 8079169	9 8843599	9 9235570	10 0764430	1	0 1920831	•1156401
60	9 8080675	9 8842540	9 9238135	10 0761865	0	0 1919325	•1157460

SINE Comple-ment.	Sine.	Tangent. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com
0	9 8080575	9 8842550	9 9238135	10 0761865	60	0 1919325	1157460
1	9 8082180	9 8841479	9 9240701	10 0759299	59	0 1917820	.1158521
2	9 8083784	9 8840481	9 9243266	10 0756734	58	0 1916316	.1159582
3	9 8085388	9 8839357	9 9245831	10 0754169	57	0 1914812	.1160643
4	9 8086990	9 8838294	9 9248396	10 0751604	56	0 1913310	.1161706
5	9 8088592	9 8837232	9 9250960	10 0749040	55	0 1911808	.1162768
6	9 8090192	9 8836168	9 9253524	10 0746476	54	0 1910308	.1163832
7	9 8091792	9 8835104	9 9256088	10 0743912	53	0 1908808	.1164896
8	9 8092691	9 8834039	9 9258652	10 0741348	52	0 1907309	.1165961
9	9 8094189	9 8832975	9 9261215	10 0738785	51	0 1905811	.1167026
10	9 8095686	9 8831908	9 9263778	10 0736222	50	0 1904314	.1168092
11	9 8097182	9 8830841	9 9266341	10 0733659	49	0 1902818	.1169159
12	9 8098678	9 8829774	9 9268904	10 0731096	48	0 1901322	.1170226
13	9 8100172	9 8828706	9 9271466	10 0728534	47	0 1899828	.1171294
14	9 8101666	9 8827238	9 9274028	10 0725972	46	0 1898334	.1172362
15	9 8103159	9 8826568	9 9276590	10 0723410	45	0 1896841	.1173432
16	9 8104650	9 8825499	9 9279152	10 0720848	44	0 1895350	.1174501
17	9 8106141	9 8824428	9 9281713	10 0718287	43	0 1893859	.1175572
18	9 1107631	9 8823357	9 9284274	10 0715726	42	0 1892369	.1176643
19	9 8109121	9 8822285	9 9286835	10 0713165	41	0 1890879	.1177715
20	9 8110609	9 8821213	9 9289396	10 0710604	40	0 1889391	.1178787
21	9 8112096	9 8820140	9 9291956	10 0708044	39	0 1887904	.1179860
22	9 8113583	9 8819067	9 9294516	10 0705484	38	0 1386417	.1180933
23	9 8115069	9 8817992	9 9297076	10 0702924	37	0 1884931	.1182008
24	9 8116554	9 8816918	9 9299636	10 0700364	36	0 1883446	.1183082
25	9 8118038	9 8815842	9 9302195	10 0697805	35	0 1881962	.1184158
26	9 8119521	9 8814766	9 9304755	10 0695245	34	0 1880479	.1185234
27	9 8121003	9 8813689	9 9307314	10 0692686	33	0 1878997	.1186311
28	9 8122484	9 8812612	9 9309872	10 0690128	32	0 1877516	.1187388
29	9 8123965	9 8811534	9 9312431	10 0687569	31	0 1876035	.1188466
30	9 8125444	9 8810455	9 9314989	10 0685011	30	0 1874556	.1189545

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. rith of Sine Com.
30	9 8125444	9 8810455	9 9314989	10 0685011	30	0 1874556	1189545
31	9 8126923	9 8809376	9 9317547	10 0682453	29	0 1873077	.1190624
32	9 8128401	9 8808296	9 9320105	10 0679895	28	0 1871599	.1195704
33	9 8129878	9 8807215	9 9322662	10 0677338	27	0 1870122	.1192785
34	9 8131354	9 8806134	9 9325220	10 0674780	26	0 1868646	.1193866
35	9 8132829	9 8805052	9 9327777	10 0672223	25	0 1867171	.1194948
36	9 8134303	9 8803970	9 9330334	10 0669666	24	0 1865697	.1196030
37	9 8135777	9 8802887	9 9332890	10 0667110	23	0 1864223	.1197113
38	9 8137250	9 8801803	9 9335446	10 0664554	22	0 1862750	.1198197
39	9 8138721	9 8800719	9 9338003	10 0661997	21	0 1861279	.1199281
40	9 8140192	9 8799634	9 9340559	10 0655441	20	0 1859808	.1200366
41	9 8141662	9 8798548	9 9343114	10 0656886	19	0 1858338	.1201452
42	9 8143131	9 8797462	9 9345670	10 0654330	18	0 1856869	.1202538
43	9 8144600	9 8796375	9 9348225	10 0651775	17	0 1855400	.1203625
44	9 8146067	9 8795287	9 9350780	10 0649220	16	0 1853933	.1204713
45	9 8147534	9 8794199	9 9353335	10 0646665	15	0 1852466	.1205801
46	9 8148999	9 8793110	9 9355889	10 0644111	14	0 1851001	.1206890
47	9 8150465	9 8792021	9 9358444	10 0641556	13	0 1849536	.1207979
48	9 8151928	9 8790930	9 9360998	10 0639002	12	0 1848072	.1209070
49	9 8153391	9 8789840	9 9363552	10 0636448	11	0 1846609	.1210160
50	9 8154854	9 8788748	9 9366105	10 0633895	10	0 1845146	.1211252
51	9 8156315	9 8787656	9 9368659	10 0631341	9	0 1843185	.1212344
52	9 8157776	9 8786563	9 9371212	10 0628788	8	0 1842225	.1213437
53	9 8159235	0 8785470	9 9373765	10 0626235	7	0 1840765	.1214530
54	9 8160694	9 8784376	9 9376318	10 0623682	6	0 1839306	.1215624
55	9 8162152	9 8783281	9 9378871	10 0621129	5	0 1837848	.1216719
56	9 8163609	9 8782186	9 9381423	10 0618577	4	0 1836391	.1217814
57	9 8165066	9 8781090	9 9383975	10 0616025	3	0 1834934	.1218910
58	9 8166521	9 8779994	9 9386527	10 0613473	2	0 1833479	.1220006
59	9 8167975	9 8778896	9 9389079	10 0610921	1	0 1832025	.1221104
60	9 8169429	9 8777799	9 9391681	10 0608369	0	0 1830571	.1222201

	SINE Comple-ment.	Sine.	Tangent. Comple-ment.	Tang.	M	

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 8169429	9 8777799	9 9391631	10 0608369	60	0 1830571	.1222201
1	9 8170882	9 8776700	9 9394182	10 0605818	59	0 1829118	.1223300
2	9 8172334	9 8775601	9 9396733	10 0603267	58	0 1827666	.1224399
3	9 8173785	9 8774501	9 9399284	10 0600716	57	0 1826215	.1225499
4	9 8175235	9 8773401	9 9401835	10 0598165	56	0 1824765	.1226599
5	9 8176685	9 8772300	9 9404385	10 0595615	55	0 1823315	.1227700
6	9 8178133	9 8771198	9 9406936	10 0593064	54	0 1821867	.1228802
7	9 8179581	9 8770096	9 9409486	10 0590514	53	0 1820419	.1229904
8	9 8181028	9 8768993	9 9412035	10 0587964	52	0 1818972	.1231007
9	9 8182474	9 8767889	9 9414585	10 0585415	51	0 1817526	.1232111
10	9 8183919	9 8766785	9 9417135	10 0582865	50	0 1816081	.1233215
11	9 8185364	9 8765680	9 9419684	10 0580316	49	0 1814636	.1234320
12	9 8186807	9 8764574	9 9422233	10 0577767	48	0 1913193	.1235426
13	9 8188250	9 8763468	9 9424782	10 0575218	47	0 1811750	.1236532
14	9 8189692	9 8762361	9 9427331	10 0572669	46	0 1810308	.1237639
15	9 8191133	9 8761253	9 9429879	10 0570121	45	0 1808867	.1238747
16	9 8192573	9 8760145	9 9432428	10 0567572	44	0 1807427	.1239855
17	9 8194012	9 8759036	9 9434976	10 0565024	43	0 1805988	.1240964
18	9 8195450	9 8757927	9 9437524	10 0562476	42	0 1804550	.1242073
19	9 8196888	9 8756816	9 9440672	10 0559928	41	0 1803112	.1243184
20	9 8198325	9 8755706	9 9442619	10 0557381	40	0 1801675	.1244294
21	9 8199761	9 8754594	9 9445166	10 0554834	39	0 1800239	.1245406
22	9 8201196	9 8753482	9 9447754	10 0552286	38	0 1798804	.1246518
23	9 8202630	9 8752369	9 9450261	10 0549739	37	0 1797370	.1247631
24	9 8204063	9 8751256	9 9452807	10 0547193	36	0 1795937	.1248744
25	9 8205496	9 8750142	9 9455354	10 0544646	35	0 1794504	.1249858
26	9 8206927	9 8749027	9 9457900	10 0542100	34	0 1793073	.1250973
27	9 8208358	9 8747912	9 9460447	10 0539553	33	0 1791642	.1252088
28	9 8209788	9 8746795	9 9462993	10 0537007	32	0 1790212	.1253205
29	9 8211217	9 8745679	9 9465539	10 0534461	31	0 1788783	.1254321
30	9 8212646	9 8744561	9 9468084	10 0531916	30	0 1787354	.1255439

SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Comple-ment.	Tang.	TANG. Comple-ment.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com.
30	9 8212646	9 8744561	9 9468084	10 0531916	30	0 1787354	•1255439
31	9 8214073	9 8743443	9 9470630	10 0529370	29	0 1785927	•1256557
32	9 8215500	9 8742325	9 9473175	10 0526825	28	0 1784500	•1257675
33	9 8216925	9 8741205	9 9475720	10 0524280	27	0 1783074	•1258795
34	9 8218351	9 8740085	9 9478265	10 0521735	26	0 1781649	•1259915
35	9 8219775	9 8738965	9 9480810	10 0519190	25	0 1780225	•1261035
36	9 8221198	9 8737844	9 9483355	10 0516645	24	0 1778802	•1262156
37	9 8222621	9 8736722	9 9485899	10 0514101	23	0 1777379	•1263278
38	9 8224042	9 8735599	9 9488443	10 0511557	22	0 1775958	•1264401
39	9 8225463	9 8734476	9 9490987	10 0509013	21	0 1773537	•1265524
40	9 8226883	9 8733352	9 9493531	10 0506469	20	0 1773117	•1266648
41	9 8228302	9 8732227	9 9496075	10 0503925	19	0 1771698	•1267773
42	9 8229721	9 8731102	9 9498619	10 0501381	18	0 1770279	•1268898
43	9 8231138	9 8729976	9 9501162	10 0498838	17	0 1768862	•1270024
44	9 8232555	9 8728849	9 9503705	10 0496295	16	0 1767445	•1271151
45	9 8233971	9 8727722	9 9506248	10 0493752	15	0 1766029	•1272278
46	9 8235386	9 8726594	9 9508791	10 0491209	14	0 1764614	•1273406
47	9 8236800	9 8725466	9 9511334	10 0488666	13	0 1763200	•1274534
48	9 8238213	9 8724337	9 9513876	10 0486124	12	0 1761787	•1275663
49	9 8239626	9 8723207	9 9516419	10 0483581	11	0 1760374	•1276793
50	9 8241037	9 8722076	9 9518961	10 0481039	10	0 1758963	•1277924
51	9 8242448	9 8720945	9 9521503	10 0478497	9	0 1757552	•1279055
52	9 8243858	9 8719813	9 9524045	10 0475955	8	0 1756142	•1280187
53	9 8245267	9 8718681	9 9526587	10 0473413	7	0 1754733	•1281319
54	9 8246676	9 8717548	9 9529128	10 0470872	6	0 1753324	•1282452
55	9 8248083	9 8716414	9 9531670	10 0468330	5	0 1751917	•1283586
56	9 8249490	9 8715279	9 9534211	10 0465789	4	0 1750510	•1284721
57	9 8250896	9 8714144	9 9536752	10 0463849	3	0 1749104	•1285856
58	9 8252301	9 8713008	9 9539293	10 0460707	2	0 1747699	•1286992
59	9 8253705	9 8711872	9 9541834	10 0458166	1	0 1746295	•1288128
60	9 8255109	9 8710735	9 9544374	10 0455626	0	0 1744891	•1289265

	SINE Comple-ment.	Sine.	TANG. Comple-ment.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com
0	9 8255109	9 8710735	9 9544374	10 0455625	60	0 1744891	•1289265
1	9 8256512	9 8709597	9 9545915	10 0453085	59	0 1743488	•1290403
2	9 8257913	9 8708458	9 9549455	10 0450545	58	0 1742087	•1291542
3	9 8259314	9 8707319	9 9551995	10 0448000	57	0 1740686	•1292681
4	9 8260715	9 8706179	9 9554535	10 0445465	56	0 1739285	•1293821
5	9 8262114	9 8705039	9 9557075	10 0442925	55	0 1737886	•1294961
6	9 8263512	9 8703898	9 9559615	10 0440385	54	0 1736488	•1296102
7	9 8264910	9 8702756	9 9562154	10 0437846	53	0 1735090	•1297244
8	9 8266307	9 8701613	9 9564694	10 0435306	52	0 1733693	•1298387
9	9 8267703	9 8700470	9 9567233	10 0432767	51	0 1732297	•1299530
10	9 8269098	9 8699326	9 9569772	10 0430228	50	0 1730902	•1300674
11	9 8270493	9 8698182	9 9572311	10 0427689	49	0 1729507	•1301818
12	9 8271887	9 8697037	9 9574850	10 0425150	48	0 1728113	•1302963
13	9 8273279	9 8695891	9 9577389	10 0422611	47	0 1726721	•1304109
14	9 8274671	9 8694744	9 9579927	10 0420073	46	0 1725329	•1305256
15	9 8276063	9 8693597	9 9582465	10 0417535	45	0 1723937	•1306403
16	9 8277453	9 8692449	9 9585004	10 0414996	44	0 1722547	•1307551
17	9 8278843	9 8691301	9 9587542	10 0412458	43	0 1721157	•1308699
18	9 8280231	9 8690152	9 9590080	10 0409920	42	0 1719769	•1309848
19	9 8281617	9 8689002	9 9592618	10 0407382	41	0 1718381	•1310998
20	9 8283006	9 8687851	9 9595155	10 0404845	40	0 1716994	•1312149
21	9 8284393	9 8686700	9 9597693	10 0402307	39	0 1715607	•1313300
22	9 8285778	9 8685548	9 9600230	10 0399770	38	0 1714222	•1314452
23	9 8287163	9 8684396	9 9602767	10 0397232	37	0 1712837	•1315604
24	9 8288547	9 8683242	9 9605305	10 0394695	36	0 1711455	•1316758
25	9 8289930	9 8682088	9 9607842	10 0392158	35	0 1710070	•1317912
26	9 8291312	9 8680934	9 9610378	10 0389622	34	0 1708688	•1319066
27	9 8292694	9 8679779	9 9612915	10 0387085	33	0 1707306	•1320221
28	9 8294075	9 8678623	9 9615452	10 0384548	32	0 1705925	•1321377
29	9 8295454	9 8677466	9 9617988	10 0382012	31	0 1704546	•1322534
30	9 8296833	9 8676309	9 9620525	10 0379475	30	0 1703167	•1323691

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com
30	9 8296833	9 8676309	9 9620525	10 0379475	30	0 1703167	•1323691
31	9 8298212	9 8675151	9 9623061	10 0376939	29	0 1701788	•1324849
32	9 8299589	9 8673992	9 9625597	10 0374403	28	0 1700411	•1326008
33	9 8300966	9 8672833	9 9628133	10 0371867	27	0 1699034	•1327167
34	9 8302342	9 8671673	9 9630669	10 0369331	26	0 1697658	•1328327
35	9 8303717	9 8670512	9 9633204	10 0366795	25	0 1696283	•1329488
36	9 8305091	9 8669351	9 9635740	10 0364260	24	0 1694909	•1330649
37	9 8306464	9 8668189	9 9638275	10 0361725	23	0 1693536	•1331811
38	9 8307837	9 8667026	9 9640811	10 0359189	22	0 1692163	•1332974
39	9 8309209	9 8665863	9 9643345	10 0356654	21	0 1690791	•1334137
40	9 8310580	9 8664699	9 9645881	10 0354119	20	0 1689420	•1335301
41	9 8311950	9 8663534	9 9648416	10 0351584	19	0 1688050	•1336466
42	9 8313320	9 8662369	9 9650951	10 0349049	18	0 1686680	•1337631
43	9 8314688	9 8661203	9 9653486	10 0346514	17	0 1685312	•1338797
44	9 8316056	9 8660036	9 9656020	10 0343980	16	0 1683944	•1339964
45	9 8317423	9 8658868	9 9658555	10 0341445	15	0 1682577	•1341132
46	9 8318789	9 8657700	9 9661089	10 0338911	14	0 1681211	•1342300
47	9 8320155	9 8656531	9 9663623	10 0336377	13	0 1679845	•1343469
48	9 8321519	9 8655362	9 9666157	10 0333843	12	0 1678481	•1344638
49	9 8322883	9 8654192	9 9668692	10 0331306	11	0 1677117	•1345808
50	9 8324246	9 8653021	9 9671225	10 0328775	10	0 1675754	•1346979
51	9 8325609	9 8651849	9 9673759	10 0326241	9	0 1674391	•1348151
52	9 8326970	9 8650677	9 9676293	10 0323707	8	0 1673030	•1349323
53	9 8328331	9 8649504	9 9678827	10 0321173	7	0 1671669	•1350495
54	9 8329691	9 8648331	9 9681360	10 0318640	6	0 1670309	•1351669
55	9 8331050	9 8647156	9 9683893	10 0316107	5	0 1668950	•1352844
56	9 8332408	9 8645981	9 9686427	10 0313573	4	0 1667592	•1354019
57	9 8333765	9 8644806	9 9688960	10 0311040	3	0 1666234	•1355194
58	9 8335122	9 8643629	9 9691493	10 0308507	2	0 1664878	•1356371
59	9 8330478	9 8642452	9 9694026	10 0305974	1	0 1663522	•1357548
60	9 8337833	9 8641275	9 9696559	10 0303441	0	0 1662167	•1358725

	SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 8337833	9 8641275	9 9596559	10 0303441	60	0 1662167	•1358725
1	9 8339183	9 8640096	9 9699091	10 0300909	59	0 1660812	•1359904
2	9 8340541	9 8638917	9 9701624	10 0298376	58	0 1659459	•1361083
3	9 8341894	9 8637737	9 9704157	10 0295844	57	0 1658106	•1362263
4	9 8343246	9 8636557	9 9706689	10 0293311	56	0 1656754	•1363443
5	9 8344597	9 8635376	9 9709221	10 0290779	55	0 1655403	•1364624
6	9 8345978	9 8634194	9 9711754	10 0288246	54	0 1654052	•1365806
7	9 8342297	9 8633011	9 9714286	10 0285714	53	0 1652703	•1366989
8	9 8348646	9 8631828	9 9716818	10 0283182	52	0 1651354	•1368172
9	9 8349994	9 8630644	9 9719350	10 0280650	51	0 1650006	•1369356
10	9 8350341	9 8629460	9 9731882	10 0278118	50	0 1648659	•1370540
11	9 8352688	9 8628274	9 9724413	10 0275587	49	0 1647312	•1371726
12	9 8354033	9 8627088	9 9726945	10 0273055	48	0 1645967	•1372912
13	9 8355378	9 8625902	9 9729477	10 0270523	47	0 1644622	•1374098
14	9 8356722	9 8624714	9 9732008	10 0267992	46	0 1643278	•1375286
15	9 8358065	9 8623526	9 9734539	10 0265461	45	0 1641934	•1376474
16	9 8359408	9 8622338	9 9737071	10 0262929	44	0 1640592	•1377662
17	9 8360750	9 8621148	9 9739602	10 0260398	43	0 1639250	•1378852
18	9 8362091	9 8619958	9 9742133	10 0257867	42	0 1637909	•1380042
19	9 8363432	9 8618767	9 9744664	10 0255336	41	0 1636569	•1381233
20	9 8364771	9 8617576	9 9747195	10 0252805	40	0 1635229	•1382424
21	9 8366109	9 8616383	9 9749726	10 0250274	39	0 1633891	•1383617
22	9 8367447	9 8615190	9 9752257	10 0247743	38	0 1632553	•1384810
23	9 8368784	9 8613997	9 9754787	10 0245213	37	0 1631216	•1386003
24	9 8370121	9 8612803	9 9757318	10 0242682	36	0 1629879	•1387197
25	9 8371456	9 8611608	9 9759849	10 0240151	35	0 1628544	•1388392
26	9 8372791	9 8610412	9 9762379	10 0237621	34	0 1627209	•1389588
27	9 8374125	9 8609215	9 9764909	10 0235091	33	0 1625875	•1390785
28	9 8375458	9 8608018	9 9267440	10 0232560	32	0 1624542	•1391982
29	9 8376790	9 8606821	9 9769970	10 0230030	31	0 1623210	•1393179
30	9 8378122	9 8605622	9 9272500	10 0227500	30	0 1621878	•1394378

SINE Complement.	Sine	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of of Sine.	Compl. Arith. of Sine Com.
30	9 8378122	9 8605622	9 9772500	10 0227500	30	0 1621878	.1394378
31	9 8379453	9 8604423	9 9775030	10 0224970	29	0 1620547	.1395577
32	9 8380783	9 8603223	9 9777560	10 0222440	28	0 1619217	.1396777
33	9 8382112	9 8602022	9 9780090	10 0219910	27	0 1617888	.1397978
34	9 8383441	9 8600821	9 9782620	10 0217380	26	0 1616559	.1399179
35	9 8384769	9 8599619	9 9785149	10 0214851	25	0 1615231	.1400381
36	9 8386096	9 8598416	9 9787679	10 0212321	24	0 1613904	.1401584
37	9 8387422	9 8597213	9 9790209	10 0209791	23	0 1612578	.1402787
38	9 8388747	9 8596009	9 9792738	10 0207262	22	0 1611253	.1403991
39	9 8390072	9 8594804	9 9795268	10 0204732	21	0 1609928	.1405196
40	9 8391396	9 8593599	9 9797797	10 0202203	20	0 1608604	.1406401
41	9 8392719	9 8592393	9 9800326	10 0199674	19	0 1607281	.1407607
42	9 8394041	9 8591186	9 9802856	10 0197144	18	0 1605959	.1408814
43	9 8395363	9 8589978	9 9805385	10 0194615	17	0 1604637	.1410022
44	9 8396684	9 8588770	9 9807914	10 0192086	16	0 1603316	.1411230
45	9 8398004	9 8587561	9 9810443	10 0189557	15	0 1601996	.1412439
46	9 8399323	9 8586351	9 9812972	10 0187028	14	0 1600677	.1413649
47	9 8400642	9 8585141	9 9815501	10 0184499	13	0 1699358	.1414859
48	9 8401959	9 8583929	9 9818030	10 0181970	12	0 1698041	.1416071
49	9 8403276	9 8582718	9 9820559	10 0179441	11	0 1696724	.1417282
50	9 8404563	9 8581505	9 9823087	10 0176913	10	0 1695407	.1418495
51	9 8405908	9 8580262	9 9825616	10 0174384	9	0 1594092	.1419708
52	9 8407223	9 8579078	9 9828145	10 0171855	8	0 1592777	.1420922
53	9 8408537	9 8577863	9 9830673	10 0169327	7	0 1591463	.1422137
54	9 8409850	9 8576648	9 9833202	10 0166798	6	0 1590150	.1423352
55	9 8411162	9 8575432	9 9835730	10 0164270	5	0 1588838	.1424568
56	9 8412474	9 8574215	9 9838259	10 0161741	4	0 1587526	.1425785
57	9 8413785	9 8572998	9 9840787	10 0159213	3	0 1586215	.1427002
58	9 8415095	9 8571779	9 9843315	10 0156685	2	0 1584905	.1428221
59	9 8416404	9 8570561	9 9845844	10 0154156	1	0 1583596	.1429439
60	9 8417713	9 8569341	9 9848772	10 0151628	0	0 1582287	.1430659

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine.	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith. of Sine Com.
0	9 8417713	9 8569341	9 9848372	10 0151628	60	0 1582287	.1430659
1	9 8419021	9 8568121	9 9850900	10 0149100	59	0 1580979	.1431879
2	9 8420328	9 8566900	9 9853428	10 0146572	58	0 1579672	.1433100
3	9 8421634	9 8565678	9 9855956	10 0144044	57	0 1578366	.1434322
4	9 8422939	9 8564455	9 9858484	10 0141516	56	0 1577061	.1435545
5	9 8424244	9 8563232	9 9861012	10 0138988	55	0 1575756	.1436768
6	9 8425548	9 8562008	9 9863540	10 0136460	54	0 1574452	.1437992
7	9 8426851	9 8560784	9 9866068	10 0133932	53	0 1573149	.1439216
8	9 8428154	9 8559558	9 9868596	10 0131404	52	0 1571846	.1440442
9	9 8429456	9 8558332	9 9871123	10 0128877	51	0 1570544	.1441668
10	9 8430757	9 8557106	9 9873651	10 0126349	50	0 1569243	.1442894
11	9 8432057	9 8555878	9 9876179	10 0123821	49	0 1567943	.1444122
12	9 8433356	9 8554650	9 9878706	10 0121294	48	0 1566644	.1445350
13	9 8434655	9 8553421	9 9881234	10 0118766	47	0 1565345	.1446579
14	9 8435953	9 8552192	9 9883761	10 0116239	46	0 1564047	.1447808
15	9 8437250	9 8550961	9 9886289	10 0113711	45	0 1562750	.1449039
16	9 8438547	9 8549730	9 9888816	10 0111184	44	0 1561453	.1450270
17	9 8439842	9 8548499	9 9891344	10 0108656	43	0 1560158	.1451501
18	9 8441137	9 8547266	9 9893871	10 0106129	42	0 1558863	.1452734
19	9 8442432	9 8546033	9 9896399	10 0103601	41	0 1557568	.1453967
20	9 8543725	9 8544799	9 9898926	10 0101074	40	0 1556275	.1455201
21	9 8445015	9 8543564	9 9901453	10 0098547	39	0 1554982	.1456436
22	9 8446310	9 8542329	9 9903981	10 0096019	38	0 1553690	.1457671
23	9 8447601	9 8541093	9 9906508	10 0093492	37	0 1552399	.1458907
24	9 8448891	9 8539856	9 9909035	10 0090965	36	0 1551109	.1460144
25	9 8450181	9 8538619	9 9911562	10 0088438	35	0 1549819	.1461381
26	9 8451470	9 8537381	9 9914089	10 0085911	34	0 1548530	.1462619
27	9 8452758	9 8536142	9 9916616	10 0083384	33	0 1547242	.1463858
28	9 8454045	9 8534902	9 9919143	10 0080857	32	0 1545955	.1465098
29	9 8455332	9 8533662	9 9921670	10 0078330	31	0 1544668	.1466338
30	9 8456618	9 8532421	9 9924197	10 0075803	30	0 1543382	.1467579

SINE Complement.	Sine.	TANG. Complement.	Tang.	M

M	Sine	SINE Complement.	Tang.	TANG. Complement.		Compl. Arith. of Sine.	Compl. Arith of Sine Com.
30	9 8456618	9 8532421	9 9924197	10 0075803	30	0 1543382	·1467579
31	9 8457903	9 8531179	9 9926724	10 0073276	29	0 1542097	·1468821
32	9 8459188	9 8529936	9 9929251	10 0070749	28	0 1540812	·1470064
33	9 8460471	9 8528693	9 9931778	10 0068222	27	0 1539529	·1471307
34	9 8461754	9 8527449	9 9934305	10 0065695	26	0 1538246	·1472551
35	9 8463036	9 8526204	9 9936832	10 0063168	25	0 1536964	·1473796
36	9 8464318	9 8524959	9 9939359	10 0060641	24	0 1535682	·1475041
37	9 8465599	9 8523713	9 9941886	10 0058114	23	0 1534401	·1476287
38	9 8466879	9 8522466	9 9944413	10 0055587	22	0 1533121	·1477534
39	9 8468158	9 8521218	9 9946940	10 0053060	21	0 1531842	·1478782
40	9 8469436	9 8519970	9 9949460	10 0050534	20	0 1530564	·1480030
41	9 8470714	9 8518721	9 9951993	10 0048007	19	0 1529286	·1481279
42	9 8471991	9 8517471	9 9954520	10 0045480	18	0 1528009	·1482529
43	9 8473267	9 8516220	9 9957047	10 0042953	17	0 1526733	·1483780
44	9 8474543	9 8514969	9 9959573	10 0040427	16	0 1525457	·1485031
45	9 8475817	9 8513717	9 9962100	10 0037900	15	0 1524183	·1486283
46	9 8477091	6 8512465	9 9964627	10 0035373	14	0 1522909	·1487535
47	9 8478365	9 8511211	9 9967154	10 0032846	13	0 1521635	·1488789
48	9 8479637	9 8509957	9 9969680	10 0030320	12	0 1520363	·1490043
49	9 8480909	9 8508702	9 9972207	10 0027793	11	0 1519091	·1491298
50	9 8482180	9 8507446	9 9974734	10 0025266	10	0 1517820	·1492554
51	9 8483450	9 8506190	9 9977260	10 0022740	9	0 1516550	·1493810
52	9 8484720	9 8504933	9 9989787	10 0020213	8	0 1515280	·1495067
53	9 8485989	0 8503675	9 9982314	10 0017686	7	0 1514011	·1496325
54	9 8487257	9 8502417	9 9984840	10 0015160	6	0 1512743	·1497583
55	9 8488524	9 8501157	9 9987367	10 0012633	5	0 1511476	·1498843
56	9 8489791	9 8499897	9 9989893	10 0010107	4	0 1510209	·1580103
57	9 8491057	9 8498637	9 9992420	10 0007580	3	0 1508943	·1501363
58	9 8492322	9 8497375	9 9994947	10 0005053	2	0 1507678	·1502625
59	9 8493586	9 8496113	9 9997473	10 0002527	1	0 1506414	·1503887
60	9 8494850	9 8494850	1 0000000	10 0000000	0	0 1505150	·1505150

SINE Complement.	Sine.	Tangent. Complement.	Tang.	M

In any Parallel of Latitude, to know how many Leagues will Answer to one degree of Longitude, in that Parallel.

The Canon is thus,

As the Radius or Sine of 90
is to the Co-ſine of the Latitude,
So is the Number of Leagues contained in one Equinoctial Degree, to the Number of Leagues anſwering to one Degree of of Longitude, in that Latitude.

For Example,

In the Latitude of 18 d. and 12 m. I demand how many Leagues Sailing in that Parallel, will alter my Longitude one Degree:

By the Inſtrument thus,

Slide 90 on the moving Sine to 71 d. 48 m. the Complement of the Latitude on the fixed, and look for 20, on the moving Line of Numbers (which is the Number of Leagues for one Degree on the Equinoctial) againſt it on the fixed, is 19, and therefore every 19 Leagues ſailed in that Latitude, altereth my Longitude one Degree. And if you deſire to know your difference of Longitude in Miles, look for 60, the Number of miles in one Degree of the Equinoctial, on the moving Line of Numbers, againſt it on the fixed is 57, the Number of miles that anſwers to one Degree of Longitude in that Parallel.

In the Latitude of 51 d. and 30 m. if it be demanded how many Leagues in that Parallel, do anſwer to one Degree of Longitude? Slide the Radius 90 d. on the moving Sine, to 38 d. 30 m. the Complement of the Latitude on the fixed, then againſt 20, on the moving Numbers, is 12 and 50 *pts.* on the fixed, which is the Number of Leagues which will alter the Longitude one Degree, in that Latitude 51 d. 30 m.: And if you would have it in miles, look for 60 on the moving Line, againſt it is 37, the Number of miles as before, on the fixed.

In any Parallel of Latitude, to know how many Leagues will Answer to one degree of Longitude, in that Parallel.

The Canon is thus,

As the Radius or Sine of 90
is to the Co-sine of the Latitude,
So is the Number of Leagues contained in one Equinoctial Degree, to the Number of Leagues answering to one Degree of of Longitude, in that Latitude.

For Example,

In the Latitude of 18 d. and 12 m. I demand how many Leagues Sailing in that Parallel, will alter my Longitude one Degree:

By the Instrument thus,

Slide 90 on the moving Sine to 71 d. 48 m. the Complement of the Latitude on the fixed, and look for 20, on the moving Line of Numbers (which is the Number of Leagues for one Degree on the Equinoctial) against it on the fixed, is 19, and therefore every 19 Leagues sailed in that Latitude, altereth my Longitude one Degree. And if you desire to know your difference of Longitude in Miles, look for 60, the Number of miles in one Degree of the Equinoctial, on the moving Line of Numbers, against it on the fixed is 57, the Number of miles that answers to one Degree of Longitude in that Parallel.

In the Latitude of 51 d. and 30 m. if it be demanded how many Leagues in that Parallel, do answer to one Degree of Longitude? Slide the Radius 90 d. on the moving Sine, to 38 d. 30 m. the Complement of the Latitude on the fixed, then against 20, on the moving Numbers, is 12 and 50 *pts.* on the fixed, which is the Number of Leagues which will alter the Longitude one Degree, in that Latitude 51 d. 30 m.: And if you would have it in miles, look for 60 on the moving Line, against it is 37, the Number of miles as before, on the fixed.

To find how many Miles do answer to many Degrees of Longitude in any Parallel.

Suppose you Sailed in the Parallel of 50 d. till you have altered your Longitude 35 d. and you would know how many miles you have sailed, you must reduce the 35 d. into miles or minutes, multiply them by 60, they make 2100, the difference of Longitude in miles. Slide the moving Sine of 90 d. to the Sine 40 d. the Complement of the Latitude, and look for 2100 on the moving Line of Numbers, and against it on the fixed, is 1350, and so many miles will answer to 35 d. in that Parallel: And if you would multiply the 35 d. by 20, the Product is 700, which look for on the moving Line of Numbers (without altering the Instrument) against it on the fixed, is 450, the Number of Leagues you have sailed in that Parallel.

Upon any Rumb proposed, to find how many Leagues do answer to one Degree in the meridian, or any great Circle.

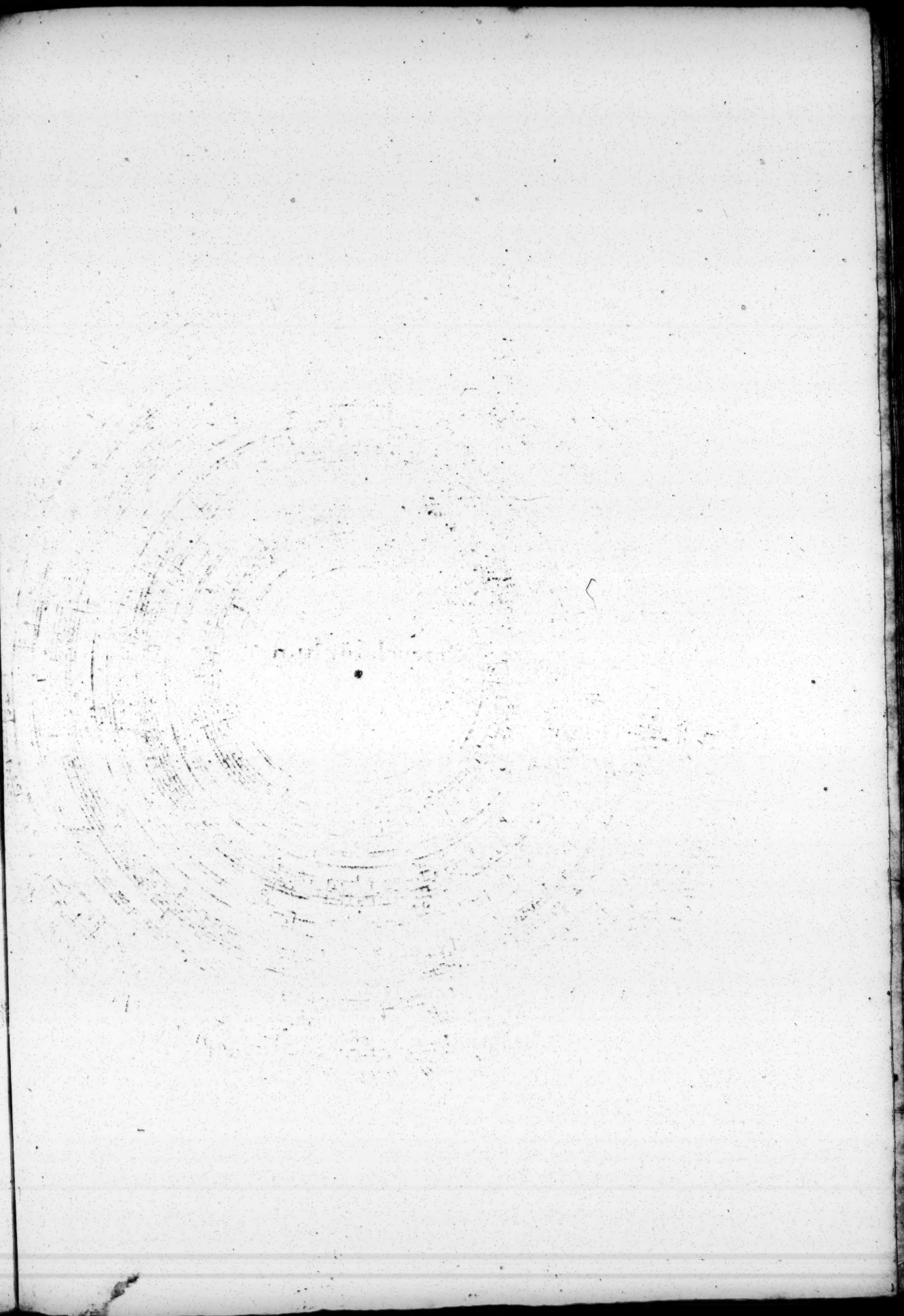
The Canon is thus, *viz.*
As the Cosine of the Rumb from the meridian,
is to the Radius 90.
So is 20 Leagues, the measure of one Degree in any great Circle,
to the Leagues that answer to one Degree on that Rumb.

Example.

Suppose you sail upon the 4*th.* Rumb from the meridian, which is the point Nor-East, or Nor-West; or else the point South-East, or South-West, and you would know upon that Rumb, how many Leagues do answer to one Degree of the meridian, or alter the Latitude one Degree.

Slide 45, the Cosine of the Rumb, from the meridian to the Radius or sine of 90, on the fixed, against 20 on the moving Line of Numbers, is 28 and almost a half in the fixed, and therefore 28 Leagues and a half make one Degree, or alters the Latitude one Degree in sailing upon that Rumb.

FINIS.



This Instrument, or ano-ther for Mathematicall Practice are made and sould by Walter Hoyer at the Dyall-Makers in Moor fields London.
And by Anselme Leinet in Britton.
Treble line of Numb
Double line of Numb
Single line of Numb
Single line of Numb
Encyclologium

Encyclologium,

OR THE

Sliding Circles.

The Argument.

It is not my present Purpose in this Book to Treat of all the Uses of this Instrument, which is so Universal, that it Answers and Resolves all Questions of Proportion, Trigonomitry, Arithmatick, Gunnery, Mensuration, Square *and* Cube-Root ; *and also* Gauging, *that requires a more particular Discourse : But of this I shortly intend to write more largely in a Treatise by it self. I therefore confine my self only to so much as pertains to* Navigation.

CHAP. I.

The Description and Use of the Instrument.

1. UPON the outmost Edge of this *Instrument* in that Circle, is a treble Line of Numbers, three times repeated, beginning and ending at the Radius *A B*. Graduated from one to ten, and from ten to a hundred (and if you please) from thence to a thousand, ending at the line *A B*, as by the Figure of the Instrument will appear.

2. On the next graduated Circles is a double line of Numbers repeated, beginning and ending at the *Radius* Line *A B*, from one to ten, and ſo on to a hundred; as in the Figure.

3. On the next graduated Circle is a ſingle line of Numbers, beginning and ending as the others, from one to ten, at the line A B. Theſe three outermoſt graduated Circles are fixed; but the two graduated Circles next within the pricked line, are moveable.

4. On the outer edge of theſe ſliding Circles, is another ſingle line of Numbers, graduated as the laſt; and in the Circle juſt under it, next to the innermoſt edge of the ſame ſliding part, is a line of *Sines*, in two Circles from 1′ to 90°, and within it is another pricked line. The next Circles within the ſecond pricked line are fixed.

5. On the outermoſt edge whereof is a line of *Sines* of the ſame Radius, beginning and ending as the former.

6. On the innermoſt edge of this fixed part is a *Tangent* line in two Circles, from a *Minute* to 45 *Degrees*, ending at the line A B.

7. The innermoſt Circles of all is another ſliding part, whereon is a *Tangent* line, beginning and ending as the former.

CHAP. II.

Multiplication, *&c. perform'd by this Inſtrument.*

TO multiply 12 by 12; look on the ſingle line of Numbers on the fixed part for 12, where the Radius line muſt be accounted for one, and two of the grand Decimal Diviſions for 2, at which is 12, and againſt it in the double line of Numbers is 144; which is the Product; and againſt that in the treble line of Numbers is 1728.

Sup-

Suppoſe in a ſquare ſolid piece of Timber of 12 *Inches, I would know how many Cubical Inches is contained therein ?*

I look in the ſingle line of *Numbers* on the fixed part for 12, and againſt it in the double is 144, and againſt that in the treble line is 1728; which is the number of *Cubical Inches* contain'd in the Piece.

By theſe two Examples you may multiply any Number by it ſelf, being equal, without moving the ſliding Circles; and alſo find the *Cubical Inches* of any ſolid Body : As alſo in

Diviſion, *without moving the ſliding Parts.*

To divide 1728 by 12, look for 1728 in the treble line of Numbers, and on the ſingle line is 12 againſt it, which is the *Deviſor*; & in the double line of *Numbers*, and between both in the lines, is 144; and ſo many times 12 you have in 1728. And thus you may divide any other Numbers.

Suppoſe the Number given were 1728 pence, and you would have it in ſhillings, divide it thus by 12 (the number of pence in a ſhilling) and the Quotient is 144 ſhillings; which being computed, is 7 *l.* 4*s.* 0 *d.*

And note : That this Inſtrument is divided and graduated *Decimally* from one to ten, and ſo to a hundred, and thouſands; every tenth is ſuppoſed to be divided into one hundred parts; the ſmalleſt Numbers are *Decimals* to the next greater Numbers, and the next greater Numbers are *Decimals* to the figured Numbers.

So if you were to compute any Sum in pounds, every pound is divided into ten, or one hundred parts of a pound; and if the ſame Number be acconnted as ſhillings, then every ſhilling is divided into 10, or 100 parts of a ſhilling ; if the ſame Number be accounted pence, its 10, or 100 parts of one penny ; and the ſame of farthings.

The Golden-Rule, *or* Rule of Three.

If 1 *Yard of* Cloth *coſt* 4 *s.* 3 *d. what will* 80 *Yards coſt?*

To work this, ſlide 1 on the moving line of Numbers, to 4.25 *pts.* on the fixed line, and againſt 80 in the moving line will be 340 on the fixed lines.

Now bring it into pounds, thus,

Slide 20, the number of ſhillings in a pound, in the moving line, to one on the fixed line of *Numbers*, and look for 340 in the moving line; againſt it, on the fixed, you have 17; which is the number of pounds contain'd in 340 *s.*

To revert the ſame Queſtion, thus,

If 80 *Yards of* Cloth *coſt* 17 *l. or* 340 *s. what will* 1 *Yard coſt?*

Slide 340 in the moving part, to 80 on the fixed, and againſt 1 in the moving line, will be 4.25 *pts.* on the fixed line of Numbers; the 4 is ſhillings, and the 25 is ſo many parts of 100, into which the ſhilling is divided; ſo you have 3 *d.* and 4 *s.* before, that is, 4 *s.* 3 *d.* one yard will coſt you.

If one pound of Tobacco *coſt* 4 *d.* 1 *q. what will* 80 *pound* coſt?

Slide 1 on the moving line of Numbers to 4.25 on the fixed line, and againſt 80 on the moving line, will be 340 on the fixed line; which is the Product in pence.

Note, That if the 80 had been 800 *l.* then the 340 had been ſo many pence; if 8000, then the product of this Number would be 34000 *d.* which may be brought into pounds or ſhillings, as above is taught.

Sup-

Suppose there should be 8 *Seamen come Home in one Ship, whose Wages come to* 124 l. A *had* 30 l. *due for Wages,* B *and* C 17 l. *a piece,* D 16 l. E 14 l. F 12 l. G 10 l. H 8 l. *By reason of some great Neglect of these Men, the Goods laden upon the said Ship sustained Damage to the value of* 40 l. *to be paid out of these Mens Wages. The Question is, What each Man ought to pay?*

To perform this, add all the Seamens Wages into one Sum, which you will find comes to 124 *l.*

Slide 124 (the whole Sum of their Wages) to 40; the Damage on the fixed line of Numbers; the Instrument thus placed, against the Sum of each Man's particular Wages in the moving Line, opposite to it on the fixed Line, you have each Man's part which he ought to pay; As,

First, I look for 30 in the moving Line of Numbers (30 *l.* being the Sum *A* was to have) against it, on the fixed Line of Numbers you have 9 and 690 *pts*, which is 9 *l.* 13 *s.* 10 *d.*

For the Wages of *B* and *C*, 17 *l.* a piece; look for 17 on the moving Line, and against it on the fixed Line, is 5 and 50 *pts.* which is 5 *l.* 10 *s.* a piece: And thus,

If you look, without moving the Instrument, for the Sum of every Man's Wages on the moving Line, against it on the fixed you have the Sum which each Man ought to pay.

D's Wages 16 *l.* must pay 5 *l.* 3 *s.* 3 *d.* *E*'s Wages 14 *l.* must pay 4 *l.* 10 *s.* *F*'s Wages 12 *l.* must pay 3 *l.* 17 *s.* 5 *d.* *G*'s Wages 10 *l.* must pay 3 *l.* 4 *s.* 7 *d.* and *H*'s Wages 8 *l.* must pay 2 *l.* 11 *s.* 10 *d.*

A Question in Fellowship *Resolved by this Instrument.*

Five Men, A, B, C, D, *and* E, *put* 300 l. *into a Stock; by which Stock they gained* 50 l. A *puts in* 84 l. B *put in* 72 l. C *put in* 48 l.

D *put in* 54 l. *and* E *put in* 42 l. *being added, make* 300 l. *The Queſtion is, What Profit is each Man's Proportion?*

Slide 3 (which repreſents 300) to 50, on the fixed Line, then againſt the Number or Proportion of each Man's Stock in the moving Line, againſt it on the fixed, is the Gain which each man muſt have.

I look for *A*'s part 84 in the moving Line, againſt it on the fixed is 14 *l.* then look 72, *B*'s part in the moving Line, againſt it on the fixed is 12 *l.* then look for 48, *C*'s part in the moving Line, and againſt it on the fixed is 8 *l.* then I look for *D*'s part, 54 in the moving Line, and againſt it on the fixed is 9 *l.* then I look for 42, the Stock which *E* put in, in the moving Line, and againſt it is 7 *l.* each Man's part being added, makes 50 *l.* the whole Profit of the above-ſaid Stock.

CHAP. III.

The Uſe of the Sliding Circles *in the Reſolving of Right-Lin'd* Plain Triangles.

CASE I.

ADmit the Baſe given to be 40 deg. *and the Angle at the Baſe* 33 deg. 45 min. *I demand the Perpendicular and the Hypothenuſe?*

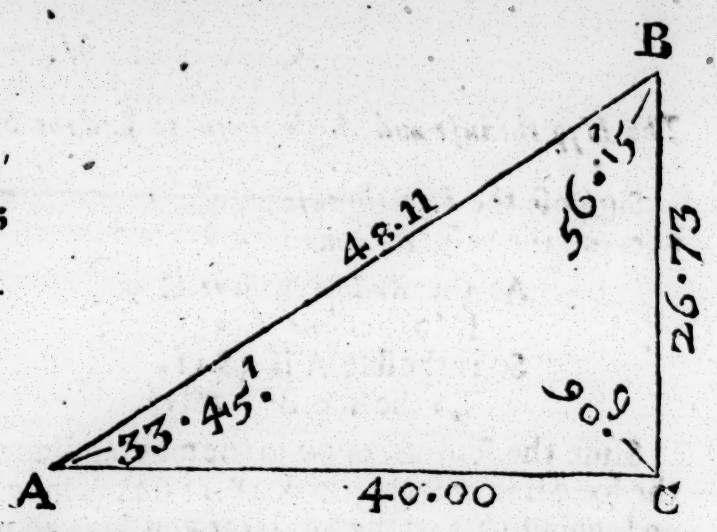
The Proportion.

As the Sine of the Angle B 56° 15',
Is to the Sine of the Angle A 33° 45';
So is the ſide A C 40,
To B C 26.73 the Perpendicular.

Caſe

CASE II.

Again,
As the Sine 56° 15′
Is to the Radius;
So is the ſide 40
To the Hypothenuſe 48 11 *pts.*



Move 56° 15′ the ſliding line of Sines, to 33° 45′ on the fixed line of Sines, and without any other motion, look for 40 in the ſingle line of Numbers; againſt that on the fixed line, you have 26.73, which is the Perpendicular required.

Next, *To find the Hypothenuſe.*

CASE III.

The Proportion.

As the Sine B 56° 15′, is to the Radius, or Sine of 90;
So is the ſide A C 40, in proportion to the Hypothenuſe 48.11.

Move 56° 15′ in the ſliding line of ſines, to the Radius or ſine of 90 on the fixed line of ſines; then look for 40 in the ſingle line of Numbers, and againſt it you have 48.11, which is the Hypothenuſe required.

Revert the ſame Caſe thus;

CASE IV.

Admit the Angle and Perpendicular were given, to find the Baſe and Hypothenuſe?

As the Sine A 33° 45′ on the moving Sines,
Is to the Sine B 56 15 on the fixed;
So is the ſide B C 26 73 *pts.* on the moving line of Numbers,
To the ſide A C 40, on the fixed line of Numbers.

The

The like may be done for the Hypothenuſe, if you uſe the Perpendicular as you did the Baſe, in the Caſe before this.

CASE V.

The Hypothenuſe and Angle given, to find the Baſe and Perpendicular.

Suppoſe the *Hypothenuſe* be 48.11, and the Angle A be 33° 45′, I demand the Baſe A C, and the Perpendicular B C?

As the *Radius* or *Sine* C 90,
Is to the *Sine* A 33° 45′;
So is the ſide A B 48.11,
To the ſide B C 26.73.

Slide the Radius, or 90 in the moving line of Sines, to 33° 45′ on the fixed line of Sines; look 48.11 on the moving line of Numbers; and againſt that on the fixed line you have 26.73 for your ſide B C.

As the Radius 90 on the moving Sines,
Is to 56° 15′ on the fixed Sines;
So is A B 48.11 in the moving line of Numbers,
To A C 40 in the fixed line of Numbers.
Againſt it is the Baſe required.

CASE VI.

The Hypothenuſe and Baſe being given, to find the Perpendicular and the Angles.

Let the Hypothenuſe A B (as before) be 48.11, and the Baſe 40, I demand the Angles?

As B A 48.11, Is to A C 40; So is the Radius C To the Sine B.

Slide B A 48.11 in the ſliding line of Numbers, to A C 40 on the fixed line of Numbers; & againſt 90 in the ſliding line of Sines you find 56° 15′ on the fixed line of Sines, which is the Angle B; which being ſubſtracted out of 90, remains 33° 45′, and is your angle at A.

As the Radius C 90, Is to the Sine A 33° 45′;
So is the Side A B, To B C required.

Move 90° in the ſliding line of Sines, to 33° 45′ on the fixed line of Sines, & where 48.11 (the ſide B A) is in the moving line of Numbers, againſt that on the fixed line is 26.73, the ſide C B required.

CHAP.

CHAP. IV.

The Uſe of this

INSTRUMENT

IN

ASTRONOMY.

HEre I undertake not (as I before acquainted you) to give inſtances of all the Caſes this Inſtrument will reſolve, but to ſelect ſome only to exerciſe and improve the ingenious Mariner, for whom I need not deſcribe the Circles of the Sphere or Globes, it being ſufficiently done in the beginning of my Syſtem of Navigation, wherein I ſuppoſe them throughly inſtructed before.

QUESTION I.

The diſtance of the Sun from the neareſt Æquinoctial point (*either* Aries *or* Libra) 58 *degrees being given, to find his Declination.*

As the Radius 90,
Is to the Sine of the Suns greateſt Declination 23° 30′;
So is the Sine of the Suns diſtance from the next Æquinoctial part *Libra*, 58°,
To the Sine of the Suns preſent Declination, 19° 45′.

Move the Radius 90 in the ſliding Sines, to 23° 30′, on the fixed Sines (the Suns greateſt Declination) & againſt 58° in the moving Sines, you have 19° 45′, which is the Suns preſent Declination.

The like Declination the Sun hath when he is in 28° 20′ of *Taurus*, in 1° 40′ of *Leo*, 28° 20′ of *Scorpio*; every of which points are diſtant from one of the Æquinoctial points *Aries* or *Libra*, 58° 45′.

QUESTION II.

The Latitude of the place 51 *degrees* 30 *minutes, and the Declination of the Sun* 19 *degrees* 45 *minutes, being given, to find the Aſcenſional difference.*

As the Co-tangent of the Latitude 38° 30′,
Is to the Tagent of the Suns Declination 19° 45′;
So is the Radius 90,
To the Sine of the Aſcenſional Difference, 26° 45′.

Move 38° 30′ (the complement of the Latitude) in the ſliding Tangent, to 19° 45′ (the Suns Declination) look on the Line of Sines, & againſt the Radius of the moving Tangent, is 26° 45′ the Aſcenſional difference; which is the time the Sun Riſeth or Setteth before Six a Clock.

So if this 26° 45′ being turn'd into time, by allowing 15° to an hour, and one degree for four minutes of time, being computed is 1*h*. 47′; and ſo much doth the Sun riſe before or after the hour of 6, according to the time or ſeaſon of the Year.

For if the Sun hath North Declination, he Riſeth before 6, if South Declination, after 6. The Aſcenſional difference being added to Six hours (the time of Noon) will give you the Semidiurnal Arch, or half length of the Day; and being Subtracted from 6 hours, will leave you the Semi-nocturnal Arch, or half length of the Night.

QUESTION

QUESTION III.

The Latitude of the place 51 *degrees* 30 *minutes, and the Declination of the Sun being given, to find the Amplitude.*

As the Co-sine of the Latitude 38° 30′,
Is to the Radius;
So the Sine of the Suns Declination 19° 45′,
To the Sine of the Amplitude from the East or West points of the Horizon, 32° 50′.

Set 38° 30′ (the complement of the Latitude in the sliding Sines) to the Radius or Sine of 90 on the fixed; then against 19° 45′ (the Suns Declination) in the moving Line of Sines, is 32° 50′, on the fixed; and so much is the Amplitude at such time as his Declination is 19° 45′.

Suppose the Suns Declination were 20° 00′, then without altering the Instrument from the places they were first set to, against 20° on the moving Line of Sines, is 33° 10′ on the fixed.

So against any other Declination on the moving Line of Sines, on the fixed, is the Amplitude of the Sun or a Star.

QUESTION IV.

The Latitude of the place 51 *degrees* 30 *minutes, and the Declination of the Sun* 19 *degrees* 45 *minutes being given, to find the Angle of the Suns Position at the time of his Rising.*

The Proportion is,
As the Co-sine of the Declination 70° 15′,
Is to the Radius 90;
So is the Sine of the Latitude 51° 30′, to the Sine of the Angle of the Suns position at the time of his Rising, 56° 00′.

Slide 70° 15′ on the moving Sine (the complement of the declination) to the Sine of 90° the Radius, on the fixed Sines, then againſt 51° 30′ (the Latitude) on the moving Sines is 56° 00′ on the fixed, being the Angle of the Suns poſition at the time of his Riſing.

QUESTION V.

The Suns Declination 19 *degrees* 45 *minutes, and his Amplitude* 32 *degrees* 50 *minutes from the Eaſt or Weſt part of the Horizon being given, to find the Latitude.*

The Proportion is,

As the Sine of the Amplitude from the Eaſt or Weſt 32° 50′,
Is to the Radius 90°;
So is the Sine of the Declination 19° 45′,
To the Co-ſine of the Latitude 38° 30′.

Slide 32° 50′ the Suns Amplitude, to the Radius or Sine of 90 on the fixed part; then look for 19° 45′ the Suns Declination, and againſt it on the fixed Sine is 38° 30′, the Complement of the Latitude 51° 30′.

QUESTION VI.

The Suns greateſt Declination 23 *degrees* 30 *minutes, with his Diſtance from the next Æquinoctial point* Aries, *or* Libra, 58 *degrees; being given, to find the Right Aſcention.*

The Proportion is,

As the Radius 90,
Is to the Co-ſine of the greateſt Declination 66° 30′;
So is the ☉'s diſtance from the next Æquinoctial point *Aries*,
To the Tangent of 55° 44′.

Slide 66° 30′ on the moving Sines, to 90° in the fixed Sines; then bring 45° on the moving Tangent, againſt 90 in the Sines: then look for 58° (the ☉'s diſtance from *Aries*) in the moving Tangent, and againſt it (in the fixed Tangent) is 55° 44′. *Queſtion*

QUESTION VII.

The Latitude of the place 51 *degrees* 30 *minutes, and the* Suns *Declination* 19 *degrees* 45 *minutes being given; to find at what hour the* Sun *will be upon the true East or West points.*

The Proportion is,

As the Tangent of the Latitude 51° 30′,
Is to the Tangent of the Suns Declination 19° 45′;
So is the Radius 90′,
To the Co-sine of the hour from Noon.

Slide the Tangent of 51° 30′ the Latitude, to the Tangent 19° 45′ on the fixed; then against the Radius 45°, on the moving Tangent you have 16° 45′ on the line of Sines; which is the Complement of the Time from *Noon*, that the *Sun* will be due *East* or *West*; and being turned into hours, will be 4 *h*. 48′. So that the ☉ when he hath 19° 45′ of *Declination*, he comes to the *East* Point at 12′ past 7 in the Morning, and will be due *West* 48′ past four in the Afternoon.

QUESTION VIII.

Having the Latitude of the Place 51 *deg.* 30 *min. and the* Sun's *Declination* 19 *deg.* 45 *min. given, to find what Altitude the* Sun *shall have when he is on the true* East *or* West *Points.*

The Proportion is,

As the *Sine* of the Lat. 51° 30′,
Is to the *Sine* of the Declination 19° 45′;
So is the Radius 90,
To the Sine of the ☉'s Altitude 25° 35′

Slide

Slide the *Sine* 51° 30′ (the Lat.) to 19° 45′ on the fixed line of *Sines*, being the Declination, and look for 90 on the moving *Sines*, againſt it you find 25° 35′, the Altitude the ⊙ will have when he is on the *Eaſt* or *Weſt* Points.

QUESTION IX.

The Latitude of the place 51 *deg.* 30 *min. and the* Sun's *Declination* 19 *deg.* 45 *min. being given, to find what Altitude the* Sun *ſhall have at the hour of ſix.*

The Proportion is,

As the Radius 90°,
Is to the *Sine* of the ⊙'s Declination 19° 45′;
So is the *Sine* of the Latitude 51° 30′
To the *Sine* of the ⊙'s Altitude at the hour of ſix, being 15° 24′.

Slide the *Sine* of 90 to the *Sine* of 19° 45′ (the ⊙'s Declination) on the fixed *Sines*; then look for 51° 24′ (the Latitude) on the moving *Sines*, and againſt it you have the *Sine* 15° 24′; the Altitude the ⊙ will have at the hour of ſix.

Theſe Queſtions might be increaſed to an infinite number, or reverted by the ſame Rules; which being (as I ſaid before) not my preſent purpoſe, ſhall therefore leave it to the Exerciſe of the more ingenious Marriner, whereby theſe hints may make ſuch Improvement of the Uſes of this Inſtrument, as will highly anſwer their Induſtry.

CHAP.

CHAP. V.

The Uſe of this

Inſtrument

IN

GUNNERY.

QUESTION I.

Knowing the Diameter and weight of one Iron Shot, *to find the weight of a greater or leſſer* Shot *of the ſame Meetle.*

Suppoſe an Iron Shot of 4 Inches Diameter weighs 9 lb, what ſhall a Shot of 8 Inches Diameter weigh ?

TO perform this, you muſt ſlide the Diameter of the leſſer ſhot to the Diameter of the greater.

Therefore ſlide 4 in the moving line of Numbers, to 8 on the fixed, then againſt 9 (the weight of your ſhot of 4 Inches) in the moving line, you have 18 on the fixed line ; then, without moving your Inſtrument, look for 18 in the moving line, and againſt it on the fixed line will be 36 ; now look for 36 in the moving line, and againſt that on the fixed you have 72 : which is the the weight of your ſhot required.

The ſame Queſtion Reſolved another way.

If an Iron Shot of 4 Inches Diameter weighs 9 lb, what ſhall an Iron Shot of 8 Inches Diameter weigh?

All Bullets having a Cubical Proportion one to another; as, by *Arithmatick*, the Cube of 4 is 64, and the Cube of 8 is 512.

To find the Cube of the two Diameters above mentioned.

Look for 4 on the ſingle fixed line of Numbers, againſt which in the double line you have 16 (the ſquare of 4) and againſt that on the treble line is 64; which is the Cube of 4.

Again (without moving the Inſtrument) look for the ſingle fixed line for 8 Inches (the other Diameter) and againſt it on the double line is 64, the ſquare of 8: and againſt that on the treble line is 512, the cube of 8: therefore you muſt ſlide 64 to 9 on the fixed line of Numbers, and look for the cube of 8 Inches, which is 512, againſt which on the fixed line is 72, the weight of a ſhot of 8 Inches Diameter.

This Inſtrument being thus ſet, will ſerve you for a *Gunners* Table, which anſwers the weights of all ſhots of the ſame Mettle, of what Diameter ſoever. It's the common Opinion of moſt Authors (of any note) and I think them very near the truth, That a ſhot of caſt Iron of 4 Inches Diameter weighs 9 lb *Aver du pois.*

Therefore the Inſtrument being ſet as in the former Queſtion, look for the Diameter of any ſhot on the fixed line of Numbers, and againſt it on the treble line, is the cube of that Diameter.

Suppoſe the Diameter 5 Inches, againſt it on the treble line is 125, which is the cube; and (without moving the Inſtrument) look for 125 on the ſliding line of Numbers, againſt that on the fixed is 17 lb and 50 *pts.* which is 17 lb and an half, the weight of your ſhot of 5 Inches.

And thus you may work any other Queſtions like this, without moving the Inſtrument.

Queſtio

QUESTION. II.

Knowing what quantity of Powder will load one Piece of Ordnance, you may know how much will load any other Piece of Ordnance.

Suppose you have a *Saker* of 3 *Inches* ¼ Bore, and it requires 4 ℔ of Powder, what will a *Demy-Cannon* of 6 inches and ⅓ require ?

To Resolve this,

Slide 3 ¼ (which is 3. 75 *pts.*) to 6.45 on the fixed line, and look for 4, the weight of Powder a *Saker* must have, which is 4 ℔ ; against this 4 on the fixed line is 6 and 900 *pts.* then look for 6 and 900 *pts* in the moving line, and against it on the fixed is 11 and 900 *pts.* then look for this 11.900 *pts.* in the moving line, and against it in the fixed you have 20.750 *pts.* which is 20 ℔. 13 ℥, the weight of Powder to charge a *Demy-Cannon.*

All Questions of this Nature being Resolved by Tables, I shall add no more in this place, having done enough to satisfie an Ingenious *Marriner*, of the usefulness of this Instrument ; the General Table of *Gunnery* you have in my *Treatise* of *Gunnery* : To which I must refer you.

But if the Bullets be of several Mettals, you must know the Proportion which one Mettle hath to another ; and therefore observe these following Directions.

The Proportion between *Lead* and *Iron* is, as 2 is to 3 : And if you would know what either of these Bullets would weigh in *Lead* :

As 2 is to 3, so 9 ℔ is to 13 ℔ ½, the weight in *Lead.* And,
As 2 is to 3, so 72 ℔ is to 108 ℔, the weight of a *Shot* eight Inches *Diameter*, in *Lead.*

The Proportion between *Iron* and *Stone* is, As 3 is to 8. But this you must understand to be of hard *Marble-Stone* which is fit for *Bullets*; and in shooting these *Bullets*, less *Powder* will serve, it being lighter Mettal.

By weight you may also find the *Diamiter* of any *Bullet* of *Lead*, *Iron*, or *Stone*, or of any other Mettal whose Proportion is known.

The Measures and Proportions of Mettals are as follow.

Lead is to *Iron* as 2 to 3.
Lead is to *Stone* as 4 to 1.
Iron is to *Stone* as 3 to 8.
Lead is to *Brass* as 24 to 19.
Iron is to *Brass* as 16 to 18.

The more exact Proportions of Mettals are these following.

Suppose a *Cube* or *Bullet* of a certain bigness to weigh 100 lb weight, the like *Cube* or *Bullet* of any of these Mettals shall weigh as followeth, and have the same Proportion.

	lb	pts.		lb	pts.
Gold	100,	00.	*Brass*	47,	37.
Quicksilver	71,	43.	*Iron*	42,	10.
Lead	60,	53.	*Tinn*	38,	95.
Silver	54,	39.	*Stone*	15,	80.
Water	5,	68.			

Now if you would find the weight of any other solid Body, though of different Mettals; By these Proportions I shall give you one Example more; by which you may perform any other Question

Quest.

QUESTION III.

If a braſs Gun weighs 3500 l. Weight, what ſhall an Iron Gun of the ſame length and thickneſs weigh?

Slide 47.37 *pts.* on the moving line of Numbers, to 42.10 on the fixed, againſt 3500 (the weight of the braſs Gun) in the moving line, is 3138 on the fixed: which is the weight of the Iron Gun.

CHAP. VI.

The Proportions for the Building of a Ship by this Inſtrument.

QUESTION I.

Suppoſe a Ship *of* 100 *Tun is* 65 *Foot by the Keel; how many Tun ſhall that* Ship *be, whoſe Keel is* 100 *Foot?*

Slide 65 (the length given) in the moving line, to 100 on the fixed line of Numbers, and look for 100 in the moving line, againſt it on the fixed is 15.35 *pts.* then look for 15.35 on the moving line, againſt it on the fixed is 236: and look for 236 in the moving line, againſt it on the fixed is 364. And ſo many *Tuns* that *Ship* will be whoſe *Keel* is 100 foot long.

To find the length of the middle Beam of the above Ship, which is 364 *Tun, without moving the Inſtrument.*

The *Ship* before mentioned of 100 *Tun*, is 22 foot by the *Beam*; look for this 22 in the moving line of Numbers, and againſt it on the fixed is 33 & 70 *pts*. And ſo much that *Ship* will be by the *Beam*, whoſe Burden is 364 *Tun*.

To find the depth of the Hold.

Suppoſe the Ships Hold before given of 100 *Tun, is* 12 *foot in the Hold: What depth ſhall this Ship be in the Hold, whoſe Burden is* 364 *Tun?*

To Reſolve this,

Look for 12 on the moving line of Numbers, and againſt it on the fixed is 18 and 35 *pts*. And ſo many foot deep the *Hold* of that *Ship* muſt be which is 100 foot by the *Keel*, 33.70 *pts*. by the *Beam*, and whoſe Burden muſt be 364 *Tun*.

QUESTION II.

For Gauging a Ship, to know how many Tuns ſhe contains, either King's, or Merchant's Tunnage.

I ſhall make uſe of the common given Number, 100 for *King's Tunnage*, and 95 for *Merchant's Tunnage*.

Suppoſe there was a Ship 46 *foot by the Keel, and* 17 *foot by the Beam, and* 9 *foot deep in the Hold; to know how many Tun ſuch a Ship will contain?*

Slide 100 in the moving line to 17 on the fixed (the breadth of the *Ship*) or the length of the main Beam; then look for 46 in

in the moving line, againſt it on the fixed is 7.84 *pts.* which I call a fourth Number; then ſlide 1 in the moving line to 7.84 *pts.* on the fixed, and look for 9 (the depth of the *Hold*) in the moving line, againſt it on the fixed is 70 *Tun*, 65 *pts.* of a *Tun*. And ſo many *Tun* will ſuch a *Ship* carry of *King's Tunnage*.

The Cannon for Merchant's Tunnage, is thus.

As 95, the Allowance for *Merchant's Tunnage*,
Is to 100, the *King's Tunnage*;
So is any other Number of *King's Tunnage*,
To *Merchant's Tunnage*.

So look for 46 in the moving line, againſt it on the fixed you have 8. 2 tenths, which is 20 *pts.* of 100, which is the 4*th.* Number. Then ſlide 1 in the moving line, to 8.2 tenths on the fixed, and look for 9 in the moving (the depth of the Hold) againſt it on the fixed is 73 Tun 75 *pts.* And ſo much this *Ship* holds *Merchant's Tunnage*.

QUESTION III.

Suppoſe I have a Ship 46 *foot by the Keel, and I would build another of* 65 *foot by the Keel; the Queſtion is, How many Tuns ſhe will be?*

Slide 45 in the moving line, to 65 on the fixed, then look for 73.75 *pts.* in the moving line, and againſt it on the fixed is 106; look for this 106 in the moving, againſt it on the fixed is 153; then look for 153 in the moving, againſt it on the fixed is 220. And ſo many Tun will the Ship be.

I ſhall give this General Rule, with a Table of Proportion; by which you may take the Proportion of any Ship, from 100 *Tun* to 800 *Tun*: and this you may enlarge to what number of *Tuns* you pleaſe.

For

For Example.

Suppoſe a Ship *of* 100 *Tun is found to be* 44 *foot by the Keel,* 20 *foot broad on the Midſhip Beam,* 9 *foot deep in the Hold, and did rake with the* Stem *forward* 13 *foot, and the the* Stern-Poſt *did rake* 7 *foot offward; and you would build another* Ship *of double her Burthen, or* 200 Tun.

The common way is to multiply all theſe Dimenſions Cubically, that is, every number by it ſelf, and the Product by it ſelf alſo.

As 44 multiplyed by 44, makes 1936; and this being multiplyed by 44, makes 85184, which is the Cube of 44: this you muſt double, by reaſon the Ship laſt propoſed is double her Burthen; which makes 170368; the *Cube-Root* of this number being extracted, is 55 foot 437 *pts.* which is 55 foot 5 inches, and almoſt 1 fourth of an inch.

Now you may *Cube* this with your Pen, as before directed; alſo for finding the *Square* and *Cube-Root*, is ſhewed by the Inſtrument in ſeveral of the foregoing Queſtions; I ſhall only add one more Example in this Queſtion.

EXAMPLE.

Look on the treble line of Numbers for 170368, under it on the ſingle line of Numbers is 55 and 4 tenths, the *Cube Root* of 170368.

Thus you may do in all other Proportions, to find the length of every one of them ſeverally; or elſe, after one Proportion is found by your Inſtrument, it ſerves as a Table to find all the other Proportions: but to make it more plain, I have inſerted this following Table of Proportional Parts.

To find the Mid-Ship Beam 20 *Foot.*

As 44 to 55 Foot 437 *pts.* So is 20 to 25 Foot 199 *pts.*

To find the depth of the Hold 9 *Foot.*

As 44 to 55 *Foot*, 437 *pts.* So is 9 to 11 Foot, 339 *pts.*

For the Raking of the Stem, 13 *Foot.*

As 44 to 55 Foot, 437 *pts.* So is 13 to 16 Foot, 379 *pts.*

For the Raking of the Stern-Post, 7 *Foot.*

As 44 to 55 Foot, 437 *pts.* So is 7 to 8 Foot, 819 *pts.*

You have here in the laſt Colume a Reſolution in feet and parts, of the Dimenſions required, ſo evident, which needs no Explanation.

Or elſe thus, having your Proportion as one *Cube* is to another.

A Table ſhewing the *Cube-Root* of the nine *Digits.*

The *Cube-Root* of one is —— 1 —— 000 *pts.*
The *Cube-Root* of 2 is —— 1 —— 260 *pts.*
The *Cube-Root* of 3 is —— 1 —— 442 *pts.*
The *Cube-Root* of 4 is —— 1 —— 557 *pts.*
The *Cube-Root* of 5 is —— 1 —— 710 *pts.*
The *Cube-Root* of 6 is —— 1 —— 817 *pts.*
The *Cube-Root* of 7 is —— 1 —— 913 *pts.*
The *Cube-Root* of 8 is —— 2 —— 000 *pts.*

The

The Table of the *Cube-Root* applyed as Cannons, to find the length of any Ship's *Keel*, whoſe Burden is from 100, to 800 *Tun*.

Ships Burdens.	Feet.Parts. Keels lengths
200 *Tun*,	as 1.000 to 44; ſo is 1.260 to 55.440
300 *Tun*,	as 1.000 to 44; ſo is 1.442 to 63.448
400 *Tun*,	as 1.000 to 44; ſo is 1.587 to 69.828
500 *Tun*,	as 1.000 to 44; ſo is 1.710 to 78.240
600 *Tun*,	as 1.000 to 44; ſo is 1.817 to 79.948
700 *Tun*,	as 1.000 to 44; ſo is 1.913 to 84.172
800 *Tun*,	as 1.000 to 44; ſo is 1.200 to 88.000

The Uſe of this Table to find the length of the *Keel*.

The aforementioned Ship being 44 foot by the *Keel*, and 100 *Tun*, to find the length of the Keel of any Ship's Burthen in the above Table.

If you would know the length of the *Keel* of a Ship, Burden 300 *Tun*: in the laſt Colume againſt 300 *Tun*, you have 63 foot, 448 *pts*. the length of your *Keel*.

Applyed to the Inſtrument, thus:

Slide 44 in the moving line 55.437 *pts*. on the fixed; againſt 20 in the moving line is 25 on the fixed: which is the length of the Mid-Beam of a Ship whoſe Burden is 200 *Tun*.

The

The Instrument thus fixed, without moving, look for 9 in the moving line (the depth in the *Hold*) against it is 11 foot 339 *pts.* the depth of the *Hold* required. *To find the Rake of the Stem*, look for 13 in the moving line, against it on the fixed is 16.379 *pts.* the *Rake* of the Ship's *Stem* required. *To find the Rake of the Stern*; look for 7 in the moving line, against it on the fixed you have 8 foot 819 *pts.* Thus sliding the length of the given *Keel* to the length of the *Keel* of that Ship whose Proportions are required, looking on the moving line of Numbers for the Proportions given, and against it on the fixed you have the length of every Proportion Resolved, as in the foregoing Example.

CHAP. VII.

The Use of the Instrument *in* Superficial *and* Solid Measures.

QUESTION I.

Suppose a Board or Plank of 15 inches ½ broad, and 18 foot long, How many foot is contain'd in that Board or Planck?

SLide 12 in the moving line to 15 and ½ the breadth, on the fixed line, then look for 18 (the length) in the moving line; against it on the fixed is 23.22 *pts.*; so many foot is contain'd in the Board or Plank.

QUESTION. II.

Suppose I have a Board or Plank of 10 inches and ½, and 21 foot and ½ long; to know the Contents of that Board or Plank.

Slide 12 in the moving line to 10 and ½, (the breadth) on the fix't, then look for 21 and ½ (the length) in the moving line; against it on the fixed is 18.92 *pts.* which is 18 foot 11 inches; and so many foot the Board or Plank contains.

QUESTION III.

To Meaſure Solids, *whoſe ſides are equal.*

Suppoſe a piece of Timber 16 *inches ſquare, and* 30 *foot long; How many ſquare foot of Timber doth that piece contain?*

Slide 12 in the moving line to 16 (the ſide of the ſquare) on the fixed; then look 30 (the length) in the moving; againſt it, on the fixed you have 40; the which 40 look for in the moving line, and againſt it, on the fixed, is 53: And ſo many foot doth that piece contain.

QUESTION IV.

Suppoſe a piece of Timber 8 *inches ſquare, and* 14 *foot and* ½ *in length; How many ſquare feet is contain'd in this piece?*

Slide 12 in the moving line to 8 (the ſquare) on the fixed, and look for 14 and ½ in the moving line, and againſt it on the fixed you have 9 and 65 *pts.* look for this 9.65 in the moving line, and againſt it in the fixed is 6.45 *pts.* And ſo many foot is contained in the piece.

If you would meaſure round Timber, you muſt firſt find the ſide of a ſquare equal to the Circumference of your piece, and then work it on your Inſtrument as the ſquare timber, as in the 3*d.* and 4*th.* Queſtions.

I might have given divers Queſtions and Examples concerning the Area of a Circle, or irregular Bodies; but in regard another *Treatiſe* of the Uſes of this Inſtrument is almoſt ready for the Preſs; principally concerning *Gauging*, meaſuring of *Solids* and *Superficies*, and will be ſhortly publiſhed, I do purpoſely avoid any more enlargement on this Subject.

CHAP.

CHAP. VIII.

The Uſe of this *Inſtrument* in *DIALLING.*

A Horizontal Dial,

IS ſuch a Plain which always lieth parallel with the Horizon, and the Zenith is the Pole; And the Stiles Elivation muſt be equal to the Latitude of the place, and therefore is given according to the Latitude 51° 30'.

The Subſtiler Line is always on the Meridian, or Hour-Line of 12, being the North and South Line.

Let the Horizontal Dial be propoſed for the Latitude 51° 30', the Canon ſtandeth thus; as the Radius is to the Sine of the Poles Elivation, ſo is the Tangent of the Hours in the Equinoctial, to the true Hours required.

Now to work this by your Inſtrument, you muſt have a ſmall braſs Index fitted to put on the Center thereof, that when Sines and Tangents muſt be uſed together, you may by help of this Index (ſo placed as to move in the Center) bring the Radius or Tangent of 45°. in a ſtreight Line even with the Radius, or moving Sign of 90°. This being done, when the Inſtrument is ſet to any proportion in Sines, and required in Tangents, it readily performs and ſerves as a Table for all the Hours diſtance from the Subſtiler Line; from which you may draw the Projection of your Dial, according to this Example:

Slide the Radius 90, on the moving Sines, to the Poles Elivation 51° 30′ on the fixed line of Sines (the Index being one) bring the edge of the Index to cut the Radius, or moving Sine of 90°, and at the same time slide 45°, the Radius on the Tangents to the edge of the Index; the Instrument thus placed, serves you as a Table for all the Hours, half, and quarter Hours, not only for this, but all sorts of North or South Dials, as you shall be informed in its proper place.

And here it must be Noted, That a Tangent runs but to 45°, and therefore this general Rule must be observed, That when your Number requires above 45° upon the moving Tangent Line, you must count back again, on the fixed; as against 40° you'l see 50, and against 30° you'l see 60, and so for the rest.

As the fixed gave you, what was required to 45°, now going back on the fixed, the moving Tangent gives what is required, to 90°, according to this Example.

Look on the moving Tangent for 15°, the first Hours distance on the Equinoctial, and against it on the fix'd Tan-
XI & I gent is 11° 50′ the true Hours distance of 11 and 1, from the Substiler, then the second Hours distance in the Equinoctial is 30°; look for 30° on the moving Tangent, against
X & II it in the fixed is 24° 20′, the true Hours distance for 10 & 2.

Then look for 45° on the moving Tangent the third Hours distance in the Equinoctial, against it on the fixed is 38° 3′,
IX & the true Hours distance for 9 and 3; now the Tangent run-
III ning no farther, you must count back again on the fixed Tangent, as you counted forward on the moving.

So if you look for 60° (the fourth Hours distance on the Equinoctial) on the fixed Tangent, against it on the moving Tangent is 53° 35′ the true Hours distance, for the
VIII & 8 and 4 Hours.
IIII

Then look for 75°, the fifth Hour in the Equinoctial on the fixed Tangent, against it on the moving is 71° 6′ the
VII & V true Hour for 7 and 5.

And look for 90° on the fixed Tangent, and against it on the moving is 90°, which is in a Horizontal Plain, the true
VI Hour of 6 in the Morning, and 6 in the Evening.

In

In a Horizontal Dial, the Meridian or 12 a Clock-Line is the Subſtile.

Fig. 1. Take 60° from your Line of Cords (which you have made on the Index of your Inſtrument) place one foot of your Compaſſes at B, and with the other draw the Semicircle A E F. Then take the Latitude of the place, as in the Figure 1. 51° 30′ and lay it from E to G, the Stiles height.

To draw the Hour-Lines of a Horizontal Dial.

For XI & I. Take 11° 50′ on the Line of Cords, placing one foot of your Compaſſes in E, and with the other cut the Semicircle on each ſide E, and draw the Lines 11 and 1.

For X & II. Take 24° 20′ and lay it off on both ſides E, as before, and draw the Lines 10 and 2 from the Center B.

For IX & III. Take 38° 8′ and from E lay it off as before, and draw the Hour-Lines of 9 and 3.

For VIII & IIII. Take 53° 35′ which lay off on both ſides E, as above, then drawing your Lines a-croſs the Center B, gives you the Hours of 8 in the Morning, and 8 at Night; and 4 in the Morning, and 4 in the Afternoon, as in the Figure.

For VI & V. Take 71° 6′ and lay it off on each ſide of E, and draw the Hour-Lines through the Center B, gives you the Hours of 7 in the Morning, and 7 at Night, and 5 in the Morning, and 5 at Night.

For VI & VI. Take the whole 90° of your Line of Cords, which will be the Line of A B F, your Eaſt and Weſt Line, and the 6th Hour in the Morning, and 6 at Night, and your Dial is finiſhed.

By

Hours Horizontal.	Equinoctial Hour.		Hours distance on the Plain.	
XII	00	00	00	00
quarter	3	45	2	56
half	7	30	5	52
3 quarter	11	15	8	51
XI & I.	15	00	11	50
quarter	15	45	14	52
half	22	30	17	57
3 quarter	26	15	21	0
X & II.	30	00	24	2
quarter	33	45	27	36
half	37	30	31	05
3 quarter	41	15	34	28
IX & III.	45	00	38	03
quarter	48	45	41	45
half	51	30	45	34
3 quarter	56	15	49	30
VIII & IV.	0	00	53	35
quarter	53	45	57	47
half	57	30	62	06
3 quarter	71	15	66	33
VII & V.	75	00	71	05
quarter	78	45	75	45
half	82	30	80	25
3 quarter	86	15	85	13
VI & VI.	90	00	90	00

By this Table you may draw the Hour-Lines of a Horizontal Dial for the ſame Latitude 51° 30′.

This Table was taken from the Inſtrument being ſet, as is mentioned after the Canon.

By the help of the foregoing Table, you may at any time make a Horizontal Dial with little or no trouble, or a new Calculation. The firſt Column is Quarters, half Hours, and Hours; the ſecond Column is Equinoctial Hours; the third Column is the Degrees and Minutes, for every Hour to be taken off your Line of Cords, and ſet on each ſide your Subſtile line, and thereby to draw your Hour Lines, as in the firſt Figure.

Note, That the Hour Line, before 6 in the Morning, and after 6 at Night, may be ſupply'd by continuing their oppoſite Hours beyond the Center; as the Hour-Line of 7 in the Morning continued, will be the Hour-Line of 7 in the Evening, *&c.*

To make a North *or* South Dial *direct upright.*

There is a little difference in theſe Dials from the Horizontal in the making, but only in the height of the Stile: In the Horizontal, you

you take the Latitude of the Place from your Line of Cords, and in the North and South Dials you must take the Complement of your Latitude (so what degrees and minutes is more than your Latitude) to 90°, where the Latitude is 51° 30′, the Complement is 38° 30′, and the Proportion for the Hours distance may be thus found (as in the former.)

As the Radius or Sine of 90° is to the Cosine of the Latitude 38° 30′, so is the Tangent of any Equinoctial Hour given, to the Tangent of your Hour required from the Substile.

Slide the Radius or Sine of 90° on the moving Sines to 38° 30′, the Cosine of the Latitude 51° 30′ on the fixed, and move the Index over the sliding Sines to 90°, slide the Tangent of 45° on the moving Tangent also, to the Index, till it lie strait with the moving Sine of 90°; and your Instrument being thus set, serves you as a Table to tell you all the degrees and minutes: which you must take off your Line of Cords for the distance of every Hour, as you did on the Horizontal Dial, in the first Figure.

Fig. 2. Having taught you how to find the Degrees and Minutes, and your Instrument being thus set; you must take 60° from your Line of Cords, and placing one foot of your Compasses in the Center L, and there with, draw the Semicircle E D K, then take 38° 30′ the Complement of your Latitude, and where your Meridian intersects the said Arch as at D, place one foot of your Compasses, and with the other cut the Arch D E at M, and draw the Line L M, which is the height of the Stile: then mark off your Hours on the Semicircle, and draw the Hour-Lines as you were taught in the first Figure; or make you a Table from the Instrument, which will be ready at all times to make a direct South Dial, with much ease; and therefore I have incerted the Table for this also.

Hours distance a direct North or South Dial.				
Hours.	Hours Equinoctial.		Hours distance on the Plain.	
XII.	00	00	00	00
quarter	03	45	2	20
half	07	30	4	41
3 quarter	11	15	7	03
XI & I.	15	00	9	28
quarter	18	45	11	56
half	22	30	14	27
3 quarter	26	15	17	04
X & II.	30	00	19	45
quarter	33	45	22	35
half	37	30	25	32
3 quarter	41	15	28	38
IX & III.	45	00	31	54
quarter	48	45	35	22
half	52	30	39	03
3 quarter	56	15	42	58
VIII & IV.	60	00	47	09
quarter	63	45	51	36
half	67	30	56	20
3 quarter	71	15	61	23
VII & V.	75	00	66	42
quarter	78	45	72	17
half	82	30	78	03
3 quarter	86	15	84	00
VI VI.	90	00	90	00

This Table is explained by the Inſtrument, as in Horizontal Dials, thus:

Look 15° the firſt Equinoctial Hour, in the moving Tangent, and againſt it on the fixed, you have 9° 28′, which is for the hour XI and I. Then look for 30° the ſecond Hours diſtance, on the moving Tangent, againſt it in the fixed is 19° 45′, which is the hours X and II. Look 45° on the moving, and againſt it in the fixed, is 31° 54′, the hours for IX and III; and now the moving Tangent Line runs no further, you muſt go back again on the fixed Line, as you were directed in the Horizontal Dial, and look for 60, on the fixed Tangent, and againſt it on the moving, you have 45° 9′, which is the hours for VIII and IV. Then look for 75° 00′ on the fixed, the 5*th* (Equinoctial Hour) againſt it on the moving Tangent, you have 66° 42′ the hours VII and V, and againſt 90°, you have 90°, which is the hours of VI and VI; and at the ſame time, you may find the true diſtance for every quarter of an Hour: It is but to allow 3° 45′ the quarter, part of 15°; for half an Hour, 7° 30′ the half of 15°, and ſo proportionable for 3 quarters.

This Table is ſo plain, that it would be but to waſte time and Paper, to trouble you with any more Diſcription of the Uſes.

This

Note, That every Equinoctial Hour is 15°, and every Degree 4 Minutes, as in the ſecond Column, which is uſed always in the Canon, with the Poles Elivation, to find the true Hour required.

Of upright Declining Dials *for any* Latitude.

It was ſufficient in making either of the forementioned Dials, to know the Latitude of the Place, for which the Dial was intended; but in all Declining Dials, you muſt know the quantity of its Declination, or the point from which it doth Decline. And it is alſo neceſſary, that beſides theſe things given, four other things muſt be known, before you can proceed to Draw your Dial.

The firſt is your Subſtile Line, or diſtance of the Stile from the 12 a Clock-Line; the ſecond is the height of the Stile, or the Elivation of the Pole above the Plain; the third is the Angle of Inclination, between the meridian of the Place, and the meridian of the Plain (commonly called the Plains difference of Longitude;) the fourth is the Angles which each Hour maketh with the Subſtile, the which you are hereby taught to find, both by Arithmatical Calculation, and by this Inſtrument, as alſo by the Tables of Artificial Sines and Tangents.

Suppoſe two Dials be required, the Latitude 51° 30′, one declining 45° to the Eaſt, and the other 45 declining to the Weſt; theſe two being joyned on a ſquare body of Wood, or Stone, at right Angles, the South declining Eaſtward, ſheweth all the Morning Hours until 2 of the Clock, and the South declining Weſtward, from 10 in the Morning until Sun-ſet, and the Corner or Angle between both, points directly to the South.

Firſt, *To find the diſtance of the Subſtile from the Meridian, or* 12 *a Clock-Line.*

The Canon is thus,

As the Raidius, or Sine of 90	10, 00000
is to the Sine of the Plains declination 45° 00′	9, 84948
So is the Tangent Complement of the Latitude 38° 30′	9, 90060
to the Tangent 29° 22′ which is the diſtance of the Subſtile from the Meridian	1, 9, 75008

Second, *To find the height of the* Pole *or* Stile *above the Plain.*

The Canon is thus,

As the Radius, or Sine of 90	10, 00000
is to the Sine Complement of the Latitude 38° 30′	9, 79414
So is the Sine Complement of the Plains declination 45 00	9, 84948
to the Sine 26° 7′ which is the height of the Stile above the Plain	*X*, 9, 64362

Third, *To find the Angle of* Inclination, *between the Meridian of the* Place, *and the Meridian of the* Plain.

The Canon is thus,

As the Sine Complement of the Latitude 38° 30′	9, 79414
is to the Radius or Sine 90	10, 00000
So is the Sine of the Subſtiles diſtance from the meridian 29° 22′	9, 69054
	1, 9, 69054
to the Sine of 51 58.	9, 89640

Which is the Inclination between the two Meridians required.

Theſe three Canons are performed by the Inſtrument thus,

The Firſt, *To find the Stiles diſtance from the Meridian.*

Slide the Radius or Sine of 90, on the moving Sine, to the Sine of 45° 00′ on the fixed, the Sine of the plains Declination, then bring the Index till it cut the moving Sine of 90° 00′, and ſlide the moving Tangent till the Radius 45° cut the edge of the Index in a ſtreight Line, with the Sine of 90: The Inſtrument being thus ſet, look for 38° 30′ (the Complement of the Latitude) on the moving Tangent, againſt it on the fixed Tangent is 29° 22′, which is the Subſtiles diſtance from the meridian required.

The Second, *To find the height of the Stile above the Plain.*

Slide the Radius or Sine of 90, on the moving Sines to the Sine of 38° 30′ (the Complement) on the fixed Sines, then look for 45° on the moving Sines (which is the Complement of your Plains Declination) againſt it on the fixed Sines you have 26° 07′, which is the height of your Stile required.

The

The Third, *To find the Angle of Inclination between the Meridian of the Place, and Meridian of the Plain.*

Slide for the Complement of the Latitude 38° 30′, on the moving Sines to the Radius, or Sine of 90, on the fixed Sines, then look for 29° 22′ the Substiles distance from the meridian, on the moving Sines, and against it on the fixed Sines is 51° 58′, which is the Inclination, or difference of Longitude between the two meridians required. And therefore I shall here direct you how to make a Table of Equinoctial Hours, which are always first given to find the true Angle that each Hour makes with the Substile.

To make the Table thus, The Plains Inclination of meridians, or difference of Longitude being found to be 51° 58′, place it against the Hour Line of 12, as you see in the Table; and from this are all your Equinoctial Hours found in Degrees and Minutes, from the Hours of 12 and 12, 51° 58′; in the Table downwards, you must add 15° to it, and it makes 66° 58′, which is the Equinoctial Hours of 1 in the East, and 11 in the West Dial; then adding 15° more to the 66° 58′ and it makes 81° 58′, which is the Equinoctial Hours for 2 in the East, and 10 in the West Dial, as you see in the Table.

The next thing is to know, between what hours your Substile Line will fall in all declining Plains.

A Table for a South Plain declining 45° East, and 45° to the West: Latitude 51° 30′.

The distance of the Substile 29° 22′
The height of the Stile 26° 07′
The Inclination of meridians or Plains difference of Longitude 51° 58′

Hours for East	Hours for West	Equinoctial Hours. Deg.	M.	Hours on the Plain. Deg.	M.
III	IX.	83	02	74	29
IV	VIII.	68	02	47	30
V	VII.	53	02	30	22
VI	VI.	38	02	19	00
VII	V	23	02	10	35
VIII	IV	08	02	03	33
The Place of the Substile.					
IX	III	06	58	03	05
X	II.	21	58	10	03
XI	I	36	58	18	20
XII	XII	51	58	29	22
I	XI	66	58	46	00
II	X	81	58	72	12

When you have found the Plains Inclination of meridians, or difference of Longitude, which is in all Decliners, placed as in the Table againſt the Hour Line of 12.

Then divide the Plains Inclination of meridians, being 51° 58′, by the Equinoctial Hour 15°, thus 51 (3 ſo here being 3 compleat Hours, 6° and 58′ over, which ſhews that three Hours from 12 a Clock; and the 6° 58′ over, being leſs then 15°, an Equinoctial Hour; tells me, that the Subſtile Line will fall between the Hours of 8 and 9 in the Eaſt, and 4 and 3 in the Weſt decliner.

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15

The 6° 58′, place it againſt the Hours of 9 in the Eaſt, and 3 in the Weſt, as in the Table; and then ſubſtract that 6° 58′ from 15° 00′ thus,

15° 00′
6 58

remains 8 02 which you muſt place againſt the Hours 8 and 4. Now the Hours between which your Subſtile falls, being found, by adding 15° to the Equinoctial Hours, above 8 and 4, and below 9 and 3, to the lower end of the Table 2 and 10. For Example,

Againſt the Hours 9 and 3, is found 6° 58′, by adding 15° to it, makes 21° 58′, the Hours of 10 and 2; then add 15° more to the 21° 58′, makes 36° 58′ the Hours of 11 and 1; then add 15° to 36° 58′, it makes 51° 58′, which is the number of Degrees before given for the Plains difference of Longitude, or Inclination of meridians. Then by adding 15° to that 51° 58′, makes 66° 58′ for the Hours of 1 in the Eaſt, and 11 in the Weſt Decliner, and ſo down to the next. Now as you added below your Subſtile, you muſt add in the ſame manner above; for Example, To the Hours of 8 and 4, you have 8° 02′, to this add 15°, it makes 23° 02′, which is the Hours of 7 in the Eaſt, and 5 in the Weſt Dial, which you muſt continue adding of 15° to the upper end of your Table.

The Fourth and laſt thing to be found, is, *The Angle that each Hour makes with the Subſtile, by the Table of Sines and Tangents, and alſo by the Inſtrument.*

The Canon of the firſt Hour from the Subſtile, is thus,

As the Radius or Sine of 90	10, 00000
is to the Sine of 26° 07′ the height of the Stile or Pole above the Plain	9, 64365
So is the Tangent of the next Equinoctial Hours diſtance to the Subſtile 6° 58′, being the Hour of 9 in the Eaſt, and 3 in the Weſt	9, 08705
to the Tangent of 3° 05′ which is the true diſtance from the Subſtile Line for the Hour of 9 on the Eaſt, and 3 on the Weſt	*R*, 8, 73070

The Canon of the ſecond Hour from the Subſtile, is thus,

As the Sine of 90	10, 00000
is to the Sine of 26° 07′ the height of the Pole	9, 64365
So is the Tangent of 21° 58′ being the ſecond Equinoctial Hours diſtance	9, 60531
to the Tangent of 10° 03′ the true diſtance of the Hours of 10 and 2 from the Subſtile	*R*, 9, 24896

The Canon of the third Hours diſtance below the Subſtile.

As the Radius or Sine of 90	10, 00000
is to the Sine of 26° 07′ the height of the Pole	9, 64365
So is the Tangent of 36° 58′, being the third Equinoctial Hours diſtance	9, 87658
to the Tangent of 18° 20′ being the diſtance from the Subſtile, for the Hours 11 and 1.	*R*, 9, 52023

This general Canon is the ſame, to find all the reſt of the Hours, as the Radius or Sine of 90 is to the Sine of the Poles height, ſo is the Tangent of any Equinoctial Hour, given to the Tangent of any Hours diſtance from the Subſtile required.

To work the same by the Instrument.

You must carefully observe, that on this Instrument there is a Tangent, and also a Sine, which begins at one Degree, and goeth to 6 Degrees, and endeth a little beyond the Sine of 90; and the Tangent of 45, as you will see on the Instrument; and the Sine, we will call the middle Sine, and the Tangent the middle Tangent; because they are only of use when the Tangent or Sine required, is under 6°; which will be in this Dial, in the two Hours next the Substile: As this Example shews you.

The Canon is thus,

As the Radius or Sine of 90
is to the Sine of the Pole or Stiles height above the Plain 26° 07′
So is the Tangent of any Equinoctial Hours distance to the Tangent of the true Hour required.

Slide the Radius or Sine of 90, on the moving Sines to the Sine of 26° 07′ the stiles height, on the fixed, and bring the Index to cut the sliding Sine of 90; then slide the Radius or Tangent of 45 deg. to cut the edge of the Index, till both come on a streight Line, on the moving Sine. The Instrument being thus placed, gives you all the Hours distances for your Dial.

For the first Hours distance from your *Substile*, look 6° 58′ on the moving Tangent, (the first Equinoctial Hours distance from the *Substiler*) against it on the middle fixed Tangent is 3° 50′, for hour 9 and 3. Then look for 8° 02′ on the moving Tangent (being the next Equinoctial Hour for the other side of your *Substiler*) against it on the middle fixed Tangent is 3° 33′, the true Hour for 8 on the East, and 4 on your West Dial. Now you have no more use of the middle Tangent in this Dial, because all the rest of the Hours reach beyond 6 deg. and fall on the Instrument as in the direct *South* Dial before mentioned, without altering the Instrument from what 'twas first set too; but when you come to use the moving Tangent beyond 45, you must count back again on the fixed, as you were then taught; so that when you look for 23° 02′ the next Equinoctial Hour, on the moving Tangent, against it on the fixed Tangent is 10° 35′, which is the true Hour required.

Then

Then look for 38° 02′, the next Equinoctial Hour on the moving Tangent, againſt it on the fixed is 19° 00′, the true Hour required for 6 in the Eaſt, and 6 on the Weſt Dial. Then look for 21° 58′ the Equinoctial Hour on the moving Tangent, againſt it in the fixed is 10 d. 03 m., the true Hours diſtance of 10 on the Eaſt, and 2 on your Weſt Dial. Then look for 36 d. 58 m. on the moving Tangent, being the Equinoctial Hours diſtance for 11 on the Eaſt, and 1 on the Weſt Dial; againſt it on the fixed Tangent 18 d. 20 m. the true Hour required.

Note, That all the reſt of the Equinoctial Hour diſtances will fall out to be more than the Radius or Tangent of 45. Therefore, as you looked for your Equinoctial Hours diſtance, before on the moving Tangent, now you muſt reckon backwards on the fixed, and the moving Tangent gives your true Hours diſtance, as the fixed did before: For you muſt Note, that the Inſtrument is Graduated and Figured back again to 90, as you find on the Inſtrument, againſt 40 is 50, againſt 30 is 60, againſt 20 is 70, againſt 10 is 80, and ſo 81 82, in ſingle Numbers to 90: therefore if you look back on the fixed Tangent for 83 d. 02 m. the Equinoctial Hour, againſt it on the moving Tangent is 74 d. 29 m., which is the true Hour for 3 on the Eaſt Dial, and 9 on the Weſt: then look for 68 d. 02 m. in the fixed Tangent, againſt it on the moving is 47 d. 29 m. the true Hours of 4 in the Eaſt, and 8 on the Weſt Dial; And thus you may do for the reſt of your Hours in the Table.

To draw a South Dial declining 45 d. 00 m. to the Eaſt.

Fig. 3. Draw upon your Plain the Horizontal Line A B, and let fall a perpendicular from C to P, for the Meridian or Hour Line of 12, then with 60 d. of your Line of Cords, ſetting one foot of your Compaſſes in the Center C, and diſcribe the Circle A S B, then laying your Table before you, and look for the diſtance of the Subſtile from the Meridian, which is 29 d. 22 m. and take the ſame from the Line of Cords, and lay it off from S to D, if the Plain decline Eaſtward, or from S to X, if the Plain decline to the Weſt; then draw the Line C D, for Subſtiler Line; and finding that the height of the Stile is 26 d. 07 m. take it from your Line of Cords, and lay from D to E, and draw the Line C E, the height of the Stile; and ſeeing the Hour Line of 9 on the Eaſt declining Plain is 3 d. 05 m. (the like is for a Weſt decliner) which 3 d. 05 m. take from your

Line

Line of Cords, and ſet it from D to 9, and draw the Line C 9. which is the Hour of IX; then take 10 d. 03 m. and lay it off as before from D to 10, and draw the Line C 10, which is the Hour of X: thus taking all your diſtances from your Table on the Line of Cords, lay them off on both ſides your Subſtile, and they repreſent the true Hour Lines, as you ſee in the Table.

Note, That your Stile ſtanding upon the Subſtile Line, is elivated above the Plain 26 d. 07 m. being equal to the Angle E C D.

Fig. 4. The Weſt declining Dial is the ſame with the Eaſt decliner, only the Subſtile muſt ſtand on the other ſide of the Meridian, or Hour Line of 12; and the Hours muſt be changed all except the 12*th*. XI on the Eaſt will be I in the Weſt; X on the Eaſt will be II on the Weſt; IX on the Eaſt, will be III on the Weſt; VIII on the Eaſt, will be IV on the Weſt; and ſo for the reſt, as you may ſee by the Figure.

For as much as it might be expected I ſhould proceed farther in Dialling, I ſhall give ſome Rules for making of an Eaſt and Weſt Dial, and alſo for Reclining and Inclining Dials.

To make an Eaſt or Weſt Dial.

Fig. 5. Theſe Dials Plain, lying in the very plain of the Meridian Circle, in which the Poles of the World are placed, therefore neither of the Poles can have any Elivation upon them: And for this Reaſon, The Hour Lines make no Angle at the Pole, and therefore the Hour Lines do not meet in a Center, but are all Parallel one to the other; ſo that in theſe Dials, there needs no Arithmatical Calculation, it ſhall be performed only by Geometical Demonſtration, as in the Figure.

Let A B C D be your Plain, on which you will draw a direct Eaſt or Weſt Dial: Firſt, Put the Point C in the lower Corner, if an Eaſt Dial, or from the Point D, if on a Weſt Dial, diſcribe an Arch of 60 d. off the Line of Cords, placing one foot on the Center C, and with it ſtrike the Arch E F F; and from the Line of Cords, take the Complement of the Latitude 38 d. 30 m. which is alſo the Elivation of the Equinoctial Circle above the Horizon, ſet this diſtance from E to F, and draw the Line C F quite through the Plain, which Line repreſents the Equinoctial Circle.

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Fig: I. *A*

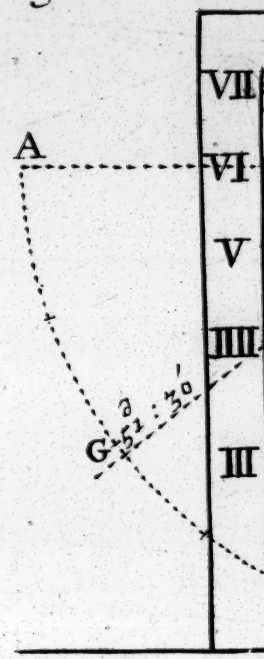
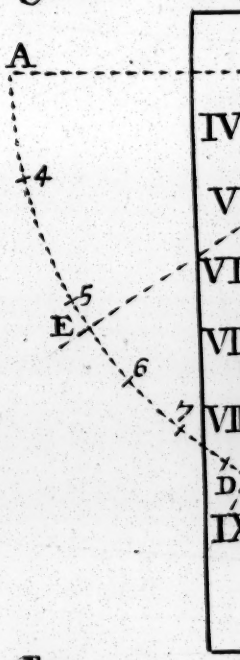
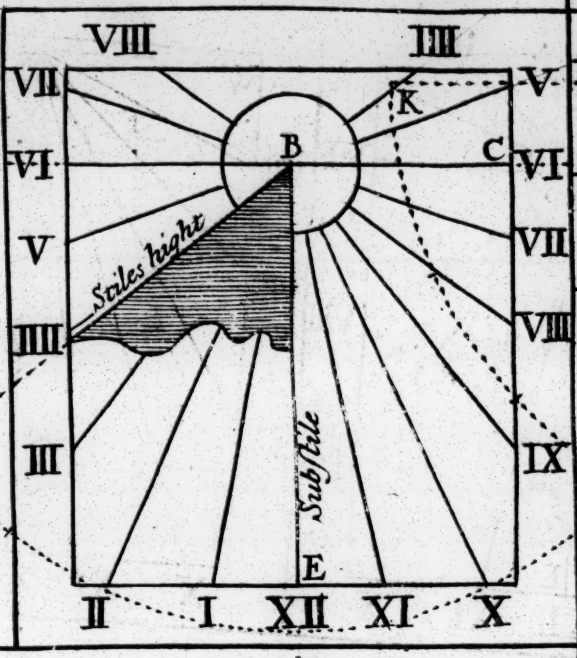


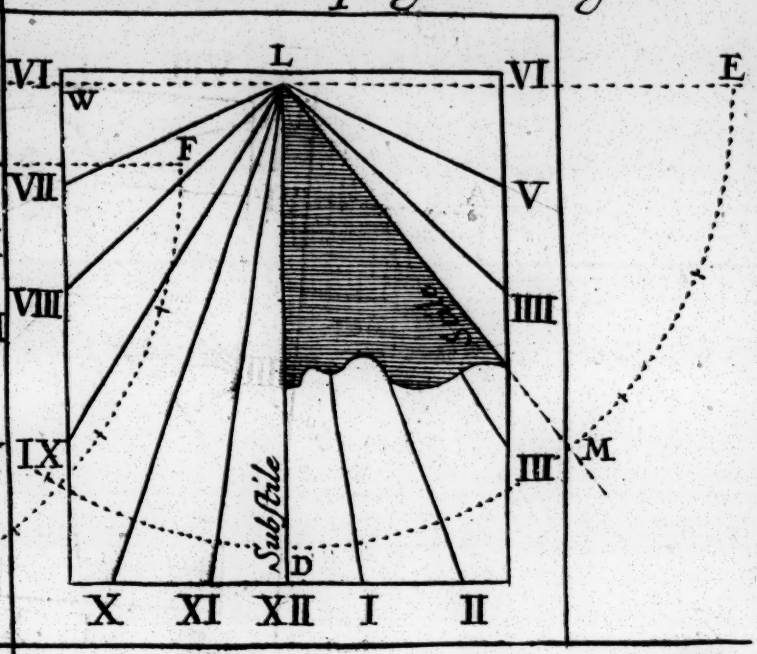
Fig: III. *La*



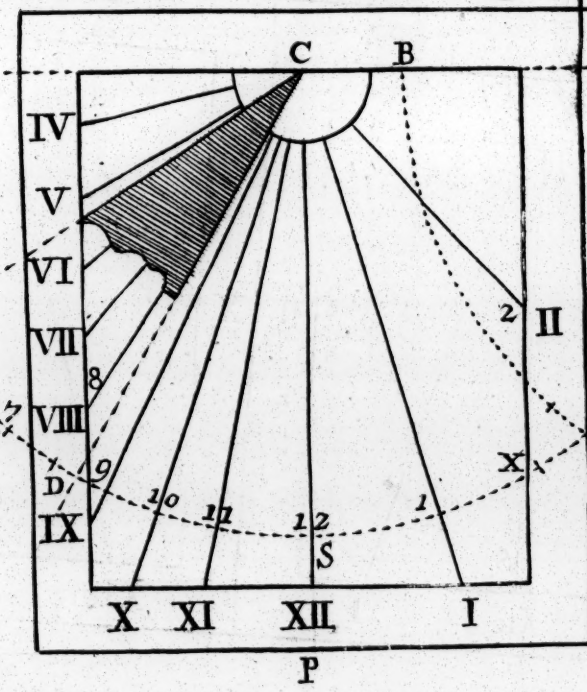
A Horizontal Diall



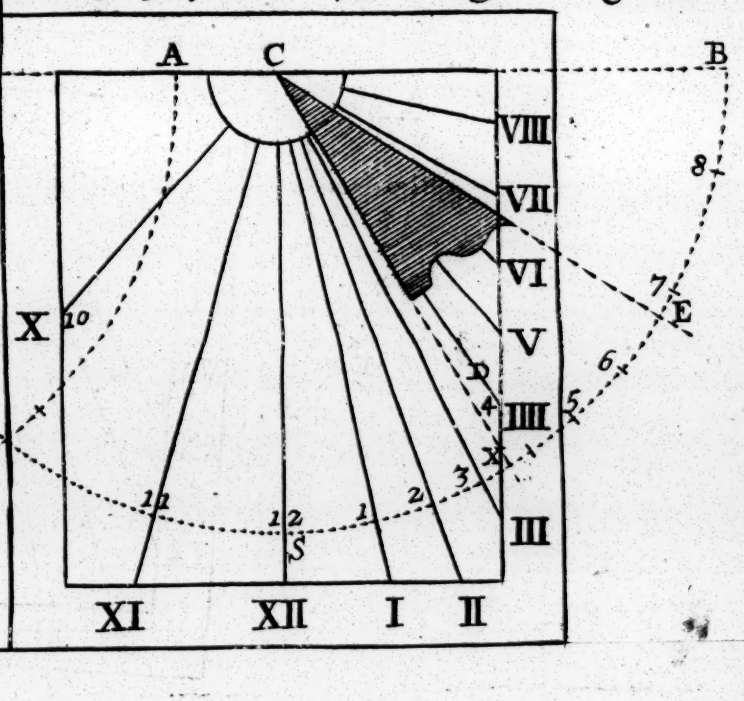
South Direct upright. *Fig:* II.



Lat: 51:30 *Declin:* 45:00 *East*



Lat: 51:30 *Declin:* 45:00: *West.* *Fig:* IIII.



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For the proportion of your Stile to the Plain, that the Hours may be at a convenient diſtance one from another, I chuſe two Points in Equinoctial Line, as in the Figure; one at G, which is the Hour of 11 in the Eaſt, or one in the Weſt Dial; the point at the upper end of the Equinoctial Line at H, is the Hours of 6 and 6; through the two points G H, draw two Lines at Right Angles to the Equinoctial, which is the Hours of 11 and 6; then from the point G with 60, of your Line of Cords, draw the Arch below the Equinoctial Line I K, and take 15° of the ſame Line of Cords, and lay it off from I to K, and draw the obſcure Line G K, to cut the Hour Line of 6 in the point L, ſo ſhall the diſtance L H, be the height of the Stile; then with 60° of your Line of Cords, ſet one foot of your Compaſſes in L, and with the other deſcribe the Arch M N, between the hour Line of 7, and the Line G L, and divide the Arch M N into 5 equal parts; which is done by taking 15° from your Line of Cords, as at theſe ooooo in the Figure, then lay a Ruler from L, to each of thoſe marks, and the Ruler will cut the Equinoctial Line C H, in theſe marks ****, through marks draw Line parallel to the hour Line of 6; as the Line VII * VII, VIII * VIII, IX * IX, X * X, which repreſents the true hour Lines of an Eaſt Dial, from 6 to 11 in the morning. For the other two Hours before 6 in the morning, take the ſame diſtance on the Equinoctial Line, between the Hours 6 and 7, the diſtance between 7 and 8, and lay them off on the Equinoctial Line from H upwards, and draw theſe Lines parallel to the 6 a Clock Line, and they will be the Hour Lines of 5 and 4 in the morning.

For the Stile of theſe Dials, it may be either an Iron Pin or Wyer, the length muſt be the diſtance between the Hour Lines of 6 and 9, which may be fixed in the point H, or ſome other in the 6 a Clock Line, and ſtand perpendicular to the Plain; or which is much better, a Plate of Copper of the ſame height, fixed on the ſame Hour Line of 6, and then your Dial is finiſhed.

To make a Weſt Dial.

Fig. 6. The Opperation is the ſame, as you have been taught in the Eaſt Dial, with this difference, That you muſt draw your Equinoctial Line from the Center D, and work in every reſpect as you did before, only in the Hours; that which is 11 in the Eaſt Dial, muſt be 1 in the Weſt, for 10 will be 2, and 9 will be 3, and

8 will be 4, and 7 will be 5 a Clock; and ſo for the reſt as you were taught in the Eaſt Dial.

To Draw Eaſt or Weſt Reclining *and* Inclining Dials.

THe beſt way is to refer them to a new Latitude, that ſo they may become an upright Declining Plain: Which you may know thus,

The New Latitude will always be the ſame with the Complement of the Latitude in which the Plain Reclineth, and the new Declination in that new Latitude, will be always the ſame with the Complement of the Plains Reclination; ſo that in the Latitude of 51° 30′, if an Eaſt or Weſt Plain ſhould Recline from the Zenith 35°, and you would know in what Latitude that Dial ſhall be an Upright Declining Plain, then Note, That the New Latitude is 38° 30′, which is the Complement of the Old Latitude; the new Declination is 55° 00′, the Complement of 35° 00′ the Plains Reclination. So if you make an Upright Dial by the foregoing Rules, for the Latitude of 38° 30′, declining 55° 00′, that Dial will be a true Dial for an Eaſt or Weſt Plain, that Reclineth 35°: In the Latitude of 51° 30′, on this you muſt obſerve, that in all Upright Declining Plains, the Hour Line of 12 is a Perpendicular, or Plumb Line, ſo the Hour Line of 12 in all Eaſt and Weſt, Reclining and Inclining Plains, will be a level or Horizontal Line, as the Line of 6 a Clock is in a North or South Plain: And you muſt alſo obſerve, that the Stiles of all Eaſt and Weſt Reclining Plains muſt point upward, towards the North Pole in North Latitude; and the Stile of all Eaſt and Weſt Inclining Plains will point downward towards the South Pole.

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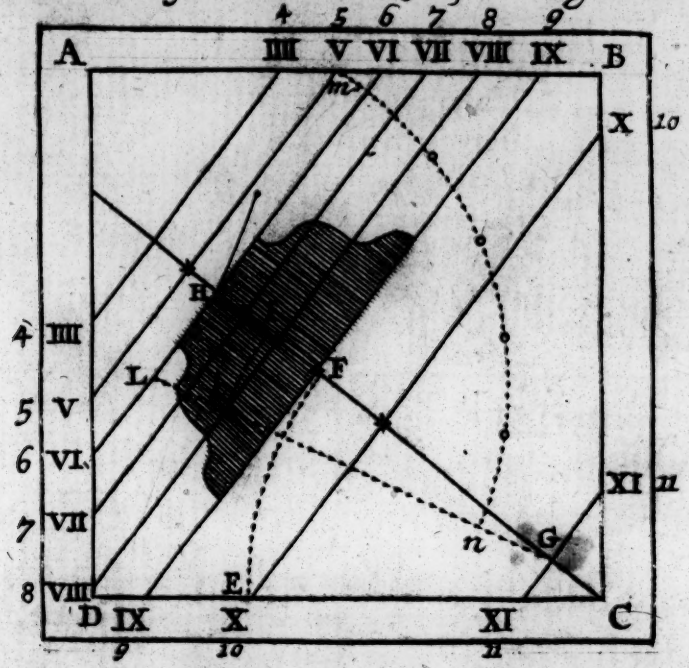
To Draw East or West Reclining, a Inclining Dials.

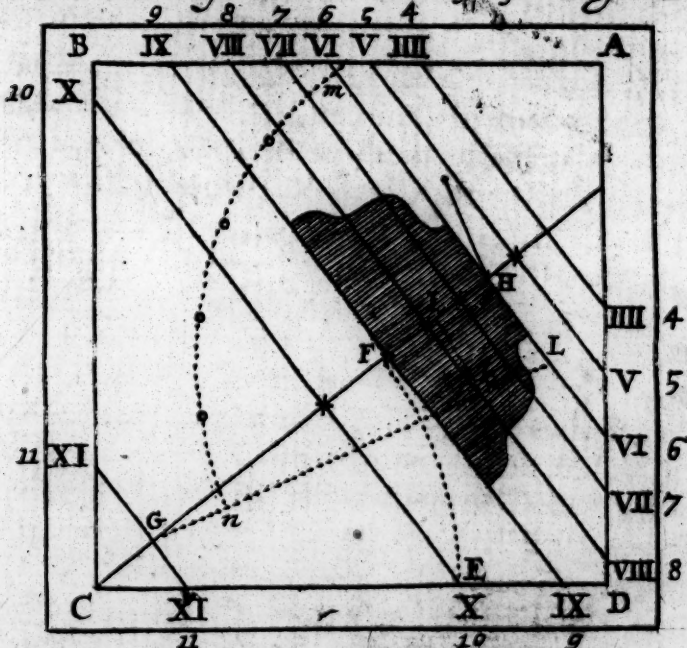
The best way is to refer them to a new Latitude, that may become an upright Declining Plain. Which know thus.

The New Latitude will always be the same with the Com of the Latitude in which the Plain Reclineth, and the ne nation in that new Latitude, will be always the same Complement of the Plains Reclination, so that in the L 51° 30', if an East or West Plain should Recline from th 35°, and you would know in what Latitude that Dial sh Upright Declining Plain, then Note, That the New La 38° 30', which is the Complement of the Old Latitude; Declination is 55° 00', the Complement of 35° 00' th Reclination. So if you make an Upright Dial by the f Rules, for the Latitude of 38° 30', declining 55° 00', t will be a true Dial for an East or West Plain, that Reclin In the Latitude of 51° 30', on this you must observe, t Upright Declining Plains, the Hour Line of 12 is a Perpe or Plumb Line, so the Hour Line of 12 in all East and W clining and Inclining Plains, will be a level or Horizontal the Line of 6 a Clock is in a North or South Plain: And also observe, that the Stiles of all East and West Reclini must point upward, towards the North Pole in North L and the Stile of all East and West Inclining Plains will poi ward towards the South Pole.

A Direct East Diall. Lat: 51:30 Fig: V.



A Direct West Diall. Lat: 51:30 Fig: VI.



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To make Direct South Reclining and North Inclining Dials.

FOr drawing of Hour Lines on these Plains, they must also be referred to a New Latitude, in which they may become Horizontal Plains; and is thus performed. If the Reclination be less than the Complement of your known Latitude, then substract your Reclination from the Complement of your known Latitude; the Remainder is your New Latitude required. As for Example,

A direct South Plain for the Latitude of 51° 30′, Reclining 18°, will be a Horizontal Dial, for the Latitude of 20° 30′, which is the New Latitude: So that if you make a Horizontal Dial, as you have been taught for the Latitude of 20° 30′, it will be a Direct South Plain Reclining 18° 00′ for the Latitude of 51° 30′.

Here it must be Noted, That when the Reclination of a South Plain, is greater than the Complement of your Latitude, then you must substract the Complement of the Latitude from your Plains Reclination, and the Remainder is the New Latitude. As for Example:

A South Plain for the Latitude of 51 d. 30 m. which Reclines 65 d. 30 m. will be a Horizontal Dial for the Latitude of 27 d. 00 m. for if you substract 38 d. 30 m. the Complement of your Latitude from 65 d. 30 m. the Plains Reclination, the Remainder is 27 d. 00 m. so that a Horizontal Dial made for the Latitude of 27 d. 00 m. will serve for a South Plain Reclining 65 d. 30 m. in the Latitude of 51 d. 30 m. If the Reclination of a South Plain be equal to the Complement of the given Latitude, then doth such a Plain lie directly in the prime Vertual Circle, and is parallel to the Axis of the World, and hath no Latitude, therefore the Pole hath no Elivation.

A Dial on such a Plain, must be made in all respects as you make an East or West Dial, only the Hour of 6 in the East or West Dial, will be the Hour Line of 12 in this, and the Equinoctial Line in this will be the same the Horizontal Line; and the height (or rather the breadth) of the Stile, will be equal to the distance that is between the Hour Line of 12, or 9 and 3.

Note, That North Inclining Dials, are the ſame with the South Recliner, being oppoſite to them, only the Figures of the Hours muſt be altered; and for the Stile, if the North Pole be Elivated upon the Recliner, the South Pole will be Elivated on the Inclining Plain, being oppoſie thereunto.

BUt you muſt remember, that North Incliners and South Inclineres, are in this contrary to the former, whereof I ſhall give you this Example: By a direct North Reclining, and South Inclining Plain, theſe Dials muſt be referred to a New Latitude, where they may become Horizontal as the former, and is thus peformed:

Add the Complement of the Latitude, and the Reclination of the Plain together, the product is the New Latitude. In the Latitude of 51 d. 30 m. a North Plain reclining 18 d. will be a Horizontal Plain for the Latitude of 56 d. 30 m.; for if you add 38 d. 30 m. the Complement of the Latitude to 18 d. 00 m. the Reclination, the product is 56 d. 30 m.: ſo that a Horizontal made for the Latitude of 56 d. 30 m. will be a North Recliner, or South Incliner for the Latitude of 51 d. 30 m.

But when the Complement of the given Latitude, and the Plains Reclination do exceed 90 d. being added together, and ſubſtracted for 180, the Remainder is your New Latitude. A North plain in the Latitude of 51 d. 30 m. Reclining 65 d. 30 m. will be a Horizontal Dial in the Latitude of 76 d. 00 m.; for if you add 38 d. 30 m. the Complement, the Latitude to 65 d. 30 m. the plains Reclination, the ſum is 104, which being above 90, ſubſtract it from 180, the Remainder is 76 d. 00 m.; ſo that a Horizontal Dial for the Latitude of 76 d. 00 m. will a North Reclining Dial 65 d. 30 m. or a South Inclining Dial for the Latitude of 51 d. 30 m.

If the Reclination of the North plain be equal to the Latitude of the place 51 d. 30 m. as in this Example, then the Reclination of the plain, and the Complement of the Latitude being added, makes 90 for your New Latitude; ſo then ſuch a plain will lie parallel to the Equinoctial in the Sphear; and to make a Dial on ſuch

ſuch a plain, you have no more to do but to divide a Circle into 24 equal parts, and drawing lines from the Center to each of thoſe parts, will be the true Hour lines for ſuch a Reclining plain; and for your Stile, 'tis no more but a ſtreight Wyer or pin, ſet up in the Center of the Circle, and your Dial is compleat.

How to find the Declination of any Plain by the Suns Azimuth from the South, *and the Horizontal diſtance from the Pole of the Plain.*

This may be performed by a Quadrant, in this manner: Apply one ſide of a Quadrant to the plain, holding it (as near as you can) parallel to the Horizon, then hold up a third, with a Plummet at the end thereof, by the limb of the Quadrant, till the ſhadow of the third paſs through the Center of the Quadrant, and then obſerve what Degrees the ſhadow of the third cutteth (accounting them from that ſide of the Quadrant, which is perpendicular to the Plain) for thoſe Degrees, and the *Horizontal Diſtance.*)—— At the ſame time (as near as may be) take the Suns *Altitude*, and from thence, find the *Azimuth*: theſe things thus attained, will give you the *Plains Declination*; and by the *Rules* following, the *Coaſt* towards which the *Plain* declineth, whether from the *North* or *South*, towards either *Eaſt* or *Weſt*, from whence all *Declinations* are accounted, and muſt never exceed 90 Degrees.

By A. M. underſtand before Noon, and by P. M. Afternoon, *&c.* by *Azim. Azimuth.*

If you take the Horizontal diſtance by a Quadrant, and a *Thred* and *Plummet*, account that ſide with *Sights*, the Right-hand ſide, and the other the Left, and either of theſe being perpendicular to the *Plain*, account the right or left ſhadow from the ſaid perpendicular ſide, *&c.*

Here-

Here follows all the Varieties that can happen.

S E { 1. From the A M Azim. ſubſtract left ſhadow,
To the A M. Azim. add right ſhadow,
From the P M right ſhadow, ſubſtract Azim.
And it gives the Degree of Declination of a plain declining South-Eaſt.

S W { 2. From A M left ſhadow ſubſtract the *Azim.*
To the P M *Azim.* add left ſhadow, or
To the P M *Azim.* ſubſtract right ſhadow,
And you have the Declination of a South Weſt plain.

If they exceed 90 Degrees,

N E { 3. Then to the A M *Azim.* add right ſhadow, and ſubduct their Sum from 180 Degrees.
But if above 180 Degrees,
To the P M *Azim.* add left ſhadow, and deduct 180 d. from it, and in both theſe Caſes, you have the Degrees of Declination of a North Eaſt plain.

N W { 4. To the P M *Azim*, add left ſhadow, and ſubduct their Sum from 180 d. if above 90 d. or to the A M *Azim*, add right ſhadow and deduct 180 therefrom, and in theſe Caſes you have the Declination of a North Weſt plain——

E { 5. If the A M *Azim.* and left ſhadow being added be juſt 90 d. or if from A M *Azim.* you ſubſtract right ſhadow and there remain 90 d. 'tis then an exact Eaſt plain.

W { 6. If from P M *Azim.* you ſubſtract left ſhadow, and there remains 90, or if to P M *Azim.* you add right ſhadow and it make 90, this is a full Weſt plain.

7. If

S { 7. If at any time before or after Noon you subſtract right or left ſhadow from the *Azim.* and there remain 00 d. 00 m. 'tis then a full South plain.

8. If at any time right or left ſhadow be added to the *Azim.* and it amounts to 180 d. then 'tis a full North plain, and theſe are all the Varieties that can happen in taking the Declination. Situation, or Poſition, of any plain that is Vertical; the Inclination and Reclination is moſt eaſily taken by a Quadrant and Ruler, well known to moſt Artificers.

ARRATA.

Theſe Faults in the Uſe of *Encyclologium*, having alſo eſcaped the *Preſs*; you are deſired to Correct as you meet them in your Reading.

PAge 4. Line 14. f r *moving*, Read fixed, p. 4. l. 22. for 340, r. product 3 0°. p. 11. l. 11. for *moving*, r. fixed, p. 11. l. 12. for *fixed*, r. moving. p. 13. l. 13. for 15 45, r. 26 51. p. 13. l. 15. for 4 h. 4 m. r. 4 h, 12 m. p. 13. l. 17. for 0 12 m. r. 0 48 m. p. 13. l. 17. for 0 48, r. 0 12 m.

In the Title Page of the Triangular Canon of Artificial Sines and Tangents, for *Supplying the Uſe of SINES*, read *Supplying the Uſe of SECANTS.*